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JET PROPULSION LABORATORY'S

QUALITY CLAUSE REQUIREMENTS

MASTER LIST

Revision K

Revision Record

Rev.#	***Effect. Date***	***Page #***	***Revision Authorized by: /Date***	***Affects:***
A	4/1/02			Original Release entire document, 82 pages
B	6/24/02			Various Changes from NASA QC team inputs, (REF QC01, QC19, QC34, QC39, QC63, QC64)
C	9/30/02			Added Table of Contents changed phone numbers.
D	11/06/02			Corrected Typos, Corrected formats, & removed embedded objects, Added QC47a, & modified QC46, QC48, and QC60 for Precap Inspection.
E	01/10/03			Corrected Typos, added page numbers, added further guidance info, indicated non-NASA requirements and info, added QC18, QC41a, QC68, QC69 and TOC, used styles to format. Changed title of document.
F	03/03/03			Change of title, Corrected Typos, changes to match with NASA clauses, added QC70, QC71
G	08/30/04	102 through 106	A.L.Deffenbaugh 08/30/04	Added QC72, QC73, QC74, QC75, QC76
H	11/09/04	8, 100-105, 107-139	A.L.Deffenbaugh 11/09/04	Added MRB hotline to QAC-01 preamble. Revised QC70, QC71, QC72, QC73, QC74, QC75. Incorporated QC77 after minor clarification. Added QC78 & QC79 for Quality System options. Added QC80-S through QC102-S for Software Quality Program
J	03/31/05	71	A.L.Deffenbaugh 03/31/05	Revised QC48 for clarification. Also removed reference to master document revision from various individual clauses in the html to prevent confusion to organizations. Reference to clause url is sufficient for purposes of determining latest version of individual clauses
K	08/15/05	33, 51, 67, 71-77, 94, 108-111, 115-117	A.L.Deffenbaugh 08/15/05	Added QC32a, QC47b, QC47c, QC47d and QC47e for Source Inspections. Revised QC62 for CAGE code instructions. Revised QC20d, QC46-N, QC47a, and QC48 to add PQA contact info. Revised QC72, QC73, QC74, QC78 and QC79 for clarification of Quality Management System approvals.

Table of Contents and Cross Reference Index for Quality Clause Requirements, Rev. K, and NASA Recommended Aerospace Quality Clauses, dated 08/15/05

The following is a table of contents for this revision.

The NASA Recommended Quality Clauses can be found at:
www.hq.nasa.gov/office/codeq/quality/qa_clause/Slide_Web_Pages/aerospace.html

Statements in bold italic letters were added because of JPL requirements.

Quality Code	NASA Code	Quality Code Title	Page No.
QAC-01		General Provisions	7
QC01-N	AQC01	Material Identification, Damage & Count	9
QC02-N	AQC05	Certificate of Compliance (C of C)	10
QC03		Certification of Compliance for Spare Parts	11
QC04		Certification to Customer's Specification Requirements	12
QC05		Supplier Designed Drawing Request (For Commercial Hardware and C.O.T.S Hardware Only)	13
QC06-N	AQC06	Certification of Compliance (C of C) for Raw Materials/Specific Lots	14
QC06a		Traceability – Raw Materials	15
QC07-N	AQC26	Electrical Wire and Cable Test Report	16
QC08-N	AQC07	Certificate of Compliance (C of C) – Calibration	17
QC09-N	AQC31	Pressure Vessel	18
QC10		Flight O-Ring Requirements	19
QC11-N	AQC30	High Strength Fastener Requirements	20
QC12-N	AQC19	Limited Life and Age Controlled (Shelf Life) Items	22
QC13		Evidence of Functional Test	23
QC14-N	AQC16	Nondestructive Inspection (NDI) / Nondestructive Test (NDT) Certification	24
QC14a		Buyers Review of Radiographic Film (NDT) Reports	25
QC15-N	AQC12	Critical Process Certification	26
QC15a		Use of Certified Critical Processor (CCP) From JPL's ASL	27
QC16		Process Procedures (for non ISO system suppliers)	28
QC17		Supplier (Sub-Tier) Process Controls	29
QC18-N	AQC04	Flow Down Requirements	30
QC19-N	AQC11	Change Control Authority	31
QC20-N	AQC15	First Article Inspection	32
QC20a	"	Delivery of First Article Inspection Records	32
QC20b	"	Retention of First Article	32
QC20c	"	Delivery of First Article	32
QC20d	"	Source Inspection of First Article	33
QC21		General Inspection of Received Sub-Components and Sub-Assemblies	34
QC21a-N	AQC17	Inspection and Test General Clause	35

Quality Code	NASA Code	Quality Code Title	Page No.
QC22		Objective Evidence of Dimensional Inspection	36
QC23		Acceptance Test Procedure Delivery for Approval	37
QC24		Qualification Test Procedure	38
QC25		Metals Control; Sheet, Tube, Rolled, Wire or Other Fabrication	39
QC25a		Weld Filler Metal Control	40
QC26-N	AQC22	Shipping Documents	41
QC27		Software Quality Assurance	42
QC28-N	AQC18	Limited Operating Life Items	43
QC29-N	AQC25	Quality Records Retention	44
QC30-N	AQC10	Configuration Management System (less than ISO 10007)	45
QC30a		Configuration Control, Pre-Submit Requirements	47
QC31-N	AQC28	EEE Single Lot/Date Code	48
QC31a-N	AQC27	EEE Parts Date of Manufacture	49
QC32		Acceptance Data Package	50
QC32a		End Item Data Package-Deliverables to Accompany PWB	51
QC33		Acceptance Data Pack – Critical Hardware	52
QC34-N	AQC20	Packaging Requirements	53
QC35-N	AQC29	Electrostatic Discharge (ESD) Protection Program and Packaging	54
QC36-N	AQC32	Solvent Containers	55
QC37		Manufacturing Planning	56
QC38		Pyrotechnic Device Manufacturing Controls	57
QC39-N	AQC23	Nonconformance Reporting	58
QC40		Material/Part Marking Required for each item	60
QC41		Material Review Board (MRB) Authority – Granted	61
QC41a		Limited Material Review Board (MRB) Authority Granted	62
QC42		Corrective Action	63
QC43		Chemicals and Material Safety Data Sheets (MSDS)	64
QC44		Use of JPL Approved Supplier List (ASL)	65
QC45		JPL Quality Assurance Site Representative Assignment	66
QC46-N	AQC14*	JPL Source Inspection	67
QC47-N	AQC13	Government Source Inspection (GSI)	68
QC47a		JPL Mandatory Inspection Points	71
QC47b		PWB Inner Layer and Final Source Inspection (JPL MIP)	72
QC47c		Pre-Cap Inspection On Electronic Parts (JPL MIP)	74
QC47d		In-Process Inspection (JPL MIP)	75
QC47e		Final Inspection (JPL MIP)	76
QC48		JPL Test Witness Source Inspection is Required	77
QC49-N	AQC09	Calibration System Requirement (for non ISO compliant or AS 9100 certified suppliers)	78
QC50		Organizational Inspection Requirements (non-flight or non-critical GSE hardware)	79
QC51		NSTS 5300.4 (Current Rev.) Inspection System	80
QC52-N	AQC02	Quality Management System	81

Quality Code	NASA Code	Quality Code Title	Page No.
QC53		Inspection System Plan	83
QC54		Organization's General Quality Assurance System Requirements for Maintenance	85
QC55		Level 1 Quality System: Quality System Requirements for Organizations who Design and Build Flight Hardware and Ground Support Equipment to Procurement Specifications	86
QC56		Level 2 Quality System: Quality System Requirements for Organizations who Build Flight Hardware and Type 1 Ground Support Equipment to Procurement Specifications	87
QC57		Level 3 Quality System: Quality System Requirements for Organizations who Modify Flight Hardware and Ground Support Equipment to Procurement Specifications	88
QC58		Level 4 Quality System: Quality System Requirements for Organizations who Provide Commercial Products	89
QC59		Level 5 Quality System: Quality System Requirements for Organizations who Provide Commercial Off-The-Shelf Products	90
QC60		Submission and Approval of Flowchart(s)	91
QC61		Oxygen Compatibility Testing	93
QC62		Manufacturer's Commercial and Government Entity (CAGE) Code	94
QC63-N	AQC03	Right of Access	95
QC64-N	AQC24	GIDEP Alert and Problem Advisories	96
QC65-N	AQC08	Special Process Certification	97
QC66		Handling of Beryllium	100
QC67		Organization's Responsibility for Supplying Electrostatic Discharge (ESD) Packaging and Personal Protective Clean Room Devices	101
QC68		Workmanship Specification	102
QC69-N	AQC21	Packaging, Handling & Labeling	105
QC70		Printed Wiring Boards (PWB)	106
QC71		Flexible and Rigid-Flexible Printed Wiring Boards	107
QC72		**Quality Management System Per AS9100**	108
QC73		Quality Management System Per AS9003	109
QC74		Quality Management System for Distributors per AS9120	110
QC75		FOD Prevention Program	112
QC76		NADCAP Accreditation of Special Process Sources	113
QC77		Electrostatic Discharge (ESD) Protection Program and Packaging (JPL D-1348)	114
QC78		Quality Management System per ISO 9001:2000	115
QC79		Quality Management System for Distributors or Manufacturers (COTS)	116
QC80-S		Use of Commercial or COTS Software As Part of Class A or Class B Software	118
QC81-S		Technical and Project Reviews	120
QC82-S		Software Configuration Management System (Less than ISO 10007)	121
QC83-S		System Requirements Review (SRR) Documentation	123
QC84-S		Software Development Environmental Changes	125
QC85-S		Software Non-conformance Reporting	126
QC86		Corrective Action Process	128

Quality Code	NASA Code	Quality Code Title	Page No.
QC87-S		Software Testing	130
QC88-S		Flight Software Margins	131
QC89-S		Preliminary Design Review (PDR) Documentation	132
QC90-S		Software Qualification Test (SQT)	133
QC91-S		Critical Design Review (CDR) Documentation	135
QC92-S		Test Readiness Review (TRR) Documentation	136
QC93-S		System Delivery Review (SDR) Documentation	138
QC94-S		Software Quality Assurance (SQA)	139
QC95-S		Independent Verification and Validation (IV&V)	140
QC96-S		Capability Maturity Model Integration (CMMI)	141
QC97-S		Software Development Programs (ISO 9000-3:1997)	142
QC98-S		Software Configuration Control	143
QC99-S		Customer Software Audits	144
QC100-S		Software Delivery Documentation	145
QC101-S		Control of Test Software	146
QC102-S		Software Quality Management System	147

QAC- 01 GENERAL PROVISION

Definitions for the purpose of this document and its related clauses are in conformance with ISO 9001:2000 and AS 9100: “Organization” is the agency with which JPL has the contract or purchase order. “Supplier” is any sub-tier to the Organization. “Customer” is JPL. For flow-down requirements, the “Organization” is the “contractor”.

The Organization shall have available and maintain a Quality System acceptable to the Customer as designated in Paragraph 1.0 of these requirements, covering the supplies hereunder. Appropriate Quality Records shall be maintained by the Organization, and shall be kept complete and available to the Customer during the performance of this purchase order, and for such period as may be specified elsewhere in this purchase order (by clause), but not less than 3 years following the completion of the purchase order.

All supplies (which include without limitation raw material, components, intermediate assemblies, assemblies, end articles, and services) shall be subject to inspection and test by Customer to the extent practical at all times and places including the period of manufacture and prior to acceptance.

In the event supplies, or lots of supplies, are defective in material or workmanship or otherwise not in conformity with the requirements of this purchase order, Customer shall have the right either to reject them (with or without instructions as to their disposition) or to require their correction. Supplies or lots of supplies that have been rejected shall be returned to the Organization at the Organization’s expense, unless for Customer’s convenience, correction is to be made at the Customer’s facility by Customer or Organization, but at Customer’s expense.

Rejected supplies shall not be resubmitted for acceptance unless the former rejection or requirement of correction is disclosed.

If the Organization fails to correct or replace non-conforming supplies or lots of supplies, in a time frame specified by Customer, Customer may, contract or otherwise replace or correct such supplies and charge to the Organization the costs incurred; terminate this purchase order for default.

The Customer reserves the right to charge any additional cost of Customer inspection and test when supplies are not ready at the time requested by Organization, or rejection of supplies by Customer. Customer shall make rejection of supplies as promptly as practicable after delivery, but failure to accept or reject supplies that are not in conformance with the purchase order shall not impose liability on the Customer.

Customer inspection and test of any supplies does not relieve Organization from any responsibility regarding defects, or other failures to meet the purchase order requirements that may be discovered prior to Customer acceptance. Acceptance inspection is to be conducted at Customer or Organization's facility at discretion of Customer, except as otherwise provided in this purchase order, acceptance shall be conclusive except as regards latent defects, fraud, or such gross mistakes as amount to fraud.

1. ORGANIZATION QUALITY ASSURANCE SYSTEM

Organization shall establish and maintain a system that provides for defect detection, identification, segregation, correction, and prevention.

2. NON-CONFORMING MATERIAL

Authority to ship discrepant material shall be obtained by Organization prior to shipment. Discrepant material shipped without prior approval will be rejected and returned to Organization at Organization's expense. If Organization has questions regarding interpretation of material requirements, up to and including the necessity for Material Review Board (MRB) actions, contact Procurement Quality Assurance MRB office at **818 354-1126**.

3. SUBSTITUTION

Under no circumstances shall Organization ship supplies that are "alternate", "equivalent", or "substitute" without written authorization from the Customer prior to the shipment.

4. SHIPPING DOCUMENTS

Organization shall furnish one (1) reproducible set of Commercial Shipping Documents and a Packing List showing the following:

- P.O. Number
- Part Number
- Description
- Qty ordered (with unit of measurement specified)
- Qty shipped (with unit of measurement specified)
- Date of shipment

This Preamble is intended to be a stated guideline of general requirements. Any conflict that may arise between the preamble and a stated Quality Clause, the Quality Clause shall take precedence.

QC01-N MATERIAL IDENTIFICATION, DAMAGE & COUNT [NASA AQC01]:

"Each article delivered under this Purchase Order will require positive identification with the part number ordered. All purchased materials and services are subject to inspection for compliance to this purchase order and all applicable quality clauses. No material or process substitutions, quantity variations or splits from the purchase order may be made without prior written authorization from the Customer."

Guidance:

- This clause might be used in lieu of C of C requirement for purchasing Commercial-Off-The-Shelf (COTS) supplies that are not critical in nature, like photocopy paper, or similar supplies.
- This information might also be included in the purchase order terms and conditions section.

QC02-N CERTIFICATE OF COMPLIANCE (C of C) [NASA AQC05]:

"Organization shall provide a certification with each shipment to attest that the parts, assemblies, subassemblies, or detail parts conform to the Order requirements. When applicable the true (original) manufacturer's, lot number, heat lot number, batch number, date code, and/or individual serial number/s must appear on the certification.

Certification must contain the following:

- Customer's Order number (JPL's)
- Line number from the Contract/Purchase Order
- Part number as identified in the Contract/Purchase Order
- Name and address of manufacturing or processing location
- Manufacturer's lot number, heat lot number, batch numbe**r**, date code, and/or serial number/s (if applicable)
- Quantity and unit of measurement (each, box, case, gallons, etc.)
- Be signed and dated by an official of the company

The applicable material test results, process certifications and inspection records shall be presented upon Customer's request. Organization shall perform inspection, as necessary, to determine the acceptability of all articles under this Order. All articles submitted by Organization under this Order are subject to final inspection at Customer's plant."

Guidance:

- When reviewing a C of C, the organizations or suppliers format should be considered acceptable as long as it contains the information noted in the clause.
- When acceptance is being made by the government, additional provisions of certification of conformance may apply. Reference FAR section 52.246-15.

http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/52_246.htm#P258_51075n

QC03 CERTIFICATION OF COMPLIANCE FOR SPARE PARTS:

"Organization shall have available for review, records of inspection/test results, and processing and material certifications as applicable for spare parts that include line replaceable units (LRU) and shop replaceable units (SRU). Organization management representative shall sign, date, and deliver with each shipment the following certification of compliance for spare parts:

'Organization certifies that parts provided to Customer under this Contract/Purchase Order:

- Are in fact the parts specified, and are spares for the end item identified in that Contract/Purchase Order;
- Are directly interchangeable with parts bearing same numbers in the referenced end item;
- Were produced under requirements and quality controls equivalent to those applicable to parts bearing same part numbers in the referenced end item;
- Were inspected/tested and found to conform to the requirements of the applicable acceptance test plan, specification, and/or drawing;
- That traceability controls are the same as those applicable to parts bearing same part numbers in the referenced end item;
- The type of data produced and/or obtained for the parts herein is similar to that produced and/or obtained for the original components of the referenced end item and shall be available to the Customer.'"

Guidance:

- Used when spare parts are purchased for the same contractual requirements, or are intended for use as spare parts to the same contract.

QC04 CERTIFICATION TO CUSTOMER'S SPECIFICATION REQUIREMENTS:

"For each item referenced in this Contract/Purchase Order, Organization shall submit one copy of all test data and/or certifications required per the applicable Customer's drawing/specification. Certifications must be signed and dated by an Organization official and must reference Customer's Contract/Purchase Order and line item. Electronic submittal will be accepted only if pre-authorized by the Customer".

Guidance:

- Required when the JPL S.O.W. requires test or certification data to be submitted for evaluation by JPL personnel

QC05 SUPPLIER DESIGNED DRAWING REQUEST (FOR COMMERCIAL HARDWARE and C.O.T.S. HARDWARE ONLY):

"For products or hardware not of Customer's design, Organization shall include in each shipment a copy of documentation related to said items (such as: drawing, catalog page, brochure, etc.), such that Customer may verify design parameters such as: test requirements, material composition, and dimensional features (including tolerances), or other applicable details".

Guidance:

- Goods designed solely to industry standards are exempt from this requirement.
- Electronic or other hardware that is not designed by JPL but has dimensional or other verifiable parametric requirements.
- Combined with general C of C requirements.

QC06-N CERTIFICATE of COMPLIANCE (C of C) RAW MATERIALS / SPECIFIC LOTS [NASA AQC06]:

"Organization shall include with each shipment the raw material manufacturer's test report (i.e., mill test report) that states that the lot of material furnished has been tested, inspected, and found to be in compliance with the applicable material specifications. The test report shall list the specifications, including revision numbers or letters, to which the material has been tested and/or inspected and the identification of the material lot to which it applies.

When the material specification requires quantitative limits for chemical, mechanical, or physical properties, the test report shall contain the actual test and/or inspection values obtained. For aluminum mill products (except castings), certifications for chemistry shall indicate compliance within the allowed range. Certifications for physical properties shall show actual values.

Reports shall be annotated to include Customer's Contract/Purchase Order and specific line item(s).

When organization supplies converted material produced by a raw material manufacturer, the organization shall submit all pre and post conversion chemical/physical tests reports and organizational 're-tests'."

Guidance:

- This clause ***shall*** be applied when procuring raw material from a distributor or raw material manufacturer. Raw materials include items such as aluminum / steel sheet, rod, and bar stock; plastics (e.g.: Teflon).
- When actual test results are desired, e.g.: flight hardware or critical GSE.
- When reviewing a raw material test report, the organizations or suppliers format should be considered acceptable as long as it contains the information noted above.

Statements in bold italic letters were added because of JPL requirements.

QC06a TRACEABILITY – RAW MATERIALS:

"Organization shall mark each individual item and applicable documentation (i.e.: test report, shipping report, or certification) to show clear traceability to lot number, heat lot number, or batch number. Unless otherwise directed by this purchase order/contract or the specification, when the size of the item does not permit marking of individual items, Organization shall label each package or box furnished".

Guidance:

- This clause would be applied when procuring raw material from a distributor or raw material manufacturer. Raw materials include items such as aluminum / steel sheet, rod, and bar stock; plastics (e.g.: Teflon). When actual test results are desired, e.g.: flight hardware or critical GSE.
- When reviewing a raw material test report, the organizations or suppliers format should be considered acceptable as long as it contains the information noted above.
- ***Combine this clause with QC25 for fabricated raw materials.***

QC07-N ELECTRICAL WIRE AND CABLE TEST REPORT [NASA AQC26]:

"Organization shall provide certification that each shipment of electrical wire or cable furnished under this contract conforms to the applicable specifications.

For each lot of wire or cable in each shipment, a certified test report or copy thereof shall be included with the packing sheet. The test report shall, at a minimum, include a record of the physical chemical, or electrical (and in the case of RF cable, electronic) inspections and tests conducted to satisfy the acceptance requirements of applicable specifications, and shall include numerical results when applicable. For cable shipments, these requirements apply to both basic wire and finished cable.

When the specification requires other inspection or test data to be reported, it shall be included in the test report

Reports shall provide the Organization or Supplier's name, the specification number and revision date or change letter, and other data required by the specification, and must be identified to or correlated with the lot shipped".

Guidance:

- To provide traceability to wire and cable purchased for flight hardware or critical GSE.
- When the S.O.W. or design engineering imposes certification to a specification requirement.
- Combined with general C of C requirements.

QC08-N CERTIFICATE of COMPLIANCE (C of C) - CALIBRATION [NASA AQC07]:

"The organization shall submit for each item calibrated, one reproducible record of actual calibration results, including applicable graphic and tabular data. Records shall be traceable to the individual item tested, by part number, serial number and customer's order number for the item shipped. The organization's calibration certificate shall include a unique calibration tracking number, tolerance range, and when applicable, environmental conditions for each parameter calibrated.

The certificate shall also state the operating error per specification, the degree of correction of out of tolerance condition and remaining uncorrected out of tolerance condition, if applicable."

Guidance:

- When contracting for product or services when verification of the calibration of the equipment is important, then this clause should be used.
- Examples include sending equipment out to its manufacturer for calibration, or the calibration of a "standard".
- Do not use this clause, if having a cal sticker on the equipment is sufficient.

- If you are requesting a certification of calibration with your procurement, you should also be using QC49-N (AQC09) Calibration System Requirement to specify that the organization have a calibration system.

QC09-N PRESSURE VESSEL [NASA AQC31]:

"With each shipment, Organization shall provide two copies of American Society of Mechanical Engineering (ASME) Code Reports showing conformance of the units to the requirements of the Pressure Vessel Code. When required, the hardware markings must be in accordance with the applicable drawing/specification. The pressures tested/certified to and the method used shall be indicated".

Guidance:

- Use for the requirement of certification of pressure vessels for facility use only.
- Not for flight hardware or critical GSE pressure vessels.

QC10 FLIGHT O-RING REQUIREMENTS:

"Shipments of flight O-rings shall meet the following:

- Individually package all O-rings in opaque packaging.
- Part mark all O-ring packages in accordance with the specification (i.e., nomenclature, part number, material specification, manufacturer's name, compound number, batch number, contract number, cure date.)
- Ship all O-rings to Buyer within two years (8 quarters) of their noted cure date.
- Provide with each shipment of O-rings a certified test report, including test results, which list the ordering and procurement specifications for each lot or batch number shipped.

NOTE: Certification must be signed and dated by a company official of Organization".

Guidance:

- Required for all flight O-rings purchased.
- Combined with general C of C requirements.

QC11-N HIGH-STRENGTH FASTENER REQUIREMENTS [NASA AQC30]:

"Organization will include with each shipment a legible copy of the Material Test Report. The report will include the following information:

a. Name and address of the manufacturer.

b. Part number and the ordering and procurement specification, including revision levels that controlled the manufacture of the goods.

c. Manufacturer's production order/lot number.

d. A copy of the Raw Material Certification from the original manufacturer.

e. Raw material data:

    1. Material specification.

    2. Alloy class, type, or grade.

    3. Raw material heat lot, lot, or melt number.

    4. Name of raw material producer.

f. Chemical analysis report.

g. Mechanical test report as defined by the applicable specification (i.e., Tensile and/or single/double shear strength, fatigue testing).

h. Metallurgical examination report as defined by the applicable specification (e.g. microstructure and/or macrostructure).

i. NDT test results: dye penetrate, or magnetic particle results, when required by applicable specification.

j. Dimensional inspection results.

If Organization is not the manufacturer, Organization's name and Customer's purchase order/contract number will be referenced on the manufacturer's certification. Include any other distributors, which have had control of the parts.

Organization's Quality Control organization shall be responsible for ensuring that items of this Order are packaged in such a manner that the dimensional integrity is preserved, contamination and corrosion are prevented, and no physical damage occurs to the threads during shipment. The preferred method, when size permits (usually #10 and MJ5 and larger), will be to individually sleeve the threaded portion of the fastener. Any method used shall insure that threads remain undamaged during shipment.

Fasteners made of plain carbon or low alloy steel shall be protected from corrosion. When plating is specified, it shall be compatible with the space environment (as appropriate). On steels harder than RC 33, plating shall be applied by a process that is not embrittling to the steel.

For flight applications, Flight Fastener Materials must have high resistance to Stress Corrosion Cracking (SCC). The allowed materials are A286, MP35N, Inconel 718 or TI-6Al-4V. For structural fasteners, the minimum required tensile strength is 160 ksi (1100 MPa). The preferred plating material is silver. Cadmium and zinc plating is prohibited.

Guidance:

- Information on lot traceability can be provided by annotating the fastener's lot number on the shipper, certification, or packing list; any one of the three will be acceptable.
- When receiving high strength fasteners for use in a critical application, the customer should test them using an independent testing laboratory. Consideration should be given to requiring that all fasteners come from a single lot, and that they be provided with the manufacturer's lot traceability number and be accompanied by the manufacturer's certification. Additional quantity should be ordered to support the need for test specimens.
- For All 1/4-inch and larger externally threaded fasteners made of A286 material used on assemblies furnished under space flight or critical GSE contract must be manufactured by one of the NASA/MSFC - approved manufacturers (Marshall Space Flight Center (MSFC) Audited Vendor List (AVL). ***(For JPL purposes, all externally threaded fasteners must be procured from an Approved Vendor for space flight fasteners, regardless of the material.)*** The MSFC AVL can be found at http://msfcsma3.msfc.nasa.gov/dbwebs/apps/avl/default.asp
- If critical fasteners are being procured from a source that is not been previously verified to have acceptable practices for fastener control, then the customer should consider whether to obtain a copy of the organizations Fastener Control Plan for review as part of the data item delivery for the contract. You should contact your appropriate customer organization for additional guidance.

Statements in bold italic letters were added because of JPL requirements.

QC12-N LIMITED LIFE AND AGE CONTROLLED (SHELF LIFE) ITEMS [NASA AQC19]:

"Products on this Order require submittal of date of manufacture when shelf life is based on date of manufacture, or date of shipment from the manufacturer when shelf life is based on date of shipment, as appropriate, based on specified method of shelf life determination.

Upon shipment, shelf life remaining shall meet the minimum shelf life specified on the order. If no shelf life is specified, 75 percent of the shelf life shall be remaining on products on this order.

Certification must contain the following:

- Customer's Order number
- Order part number
- Manufacturer's name, lot number, heat lot number, batch number, date code, and/or serial number (as applicable)
- Date of manufacture
- Date of shipment from manufacturer (as specified on Order)
- Organization name, and Organization's point of contact
- Date of Certificate"

Guidance:

- When the Customer may desire the Organization to provide evidence of certification to limited life and age controlled sensitive products. Examples include paints, epoxies, sealants, adhesives, thinners and activators.

Definitions:

Shelf Life: A predetermined period of time that a material or item retains its original characteristics and operational capacity and is further defined to encompass the Date of Expiration (DOE) and the time span from Date of Manufacture (DOM), Date of Shipment (DOS), Date of Receipt (DOR) or cure date to the installation or application date.

QC13 EVIDENCE OF FUNCTIONAL TEST:

"Organization shall provide quantitative results (i.e. demonstration of nominal operating load or pressure, maximum proof load or pressure the hardware was subjected to, electrical resistance & continuity) of functional test and a certification stating the test and inspection was performed in accordance with the Contract/Purchase Order requirements. Sketches and/or drawing of the test setup shall remain on file by the Organization for a period of 3 years, (unless otherwise specified), and be available for review by Customer. Certifications of functional tests shall be signed and dated by an official of the Organization and included the Customer's Contract/Purchase Order and line item number".

Guidance:

- When functional testing, proof loading or other tangible proof of testing is required per the P.O. or S.O.W. to be provided to, or available for review by JPL.

QC14-N NONDESTRUCTIVE INSPECTION (NDI) / NONDESTRUCTIVE TEST (NDT) CERTIFICATION [NASA AQC16]:

"Organization will include with each shipment a certificate for the NDI/NDT performed. As a minimum, the certification shall contain the following information:

- Customer's Purchase Order/Contract number
- Name and address of the Company performing NDI/NDT;
- Date of Inspection;
- Quantity of parts tested by part number;
- Specification or other requirement defining the NDI/NDT acceptance/rejection criteria;
- Inspector/name/stamp and NDI/NDT certification level;
- NDI/NDT specification including revision;
- Material or item identification (part number, heat lot number, Foundry Record (FR) number;
- Material or item traceability (serial number, lot number, batch number, lot/date code);
- Inspection results (accept/reject);
- Reference to previous NDI/NDT reports for repair/rework if applicable;
- Reference to attached recordings i.e., films or photographs if applicable;

A record of the procedures or techniques used and actual results shall remain on file for at least five years after shipment to Customer and shall be furnished to Customer upon request. These records shall include all information required in the previous paragraph as well as acceptance/rejection criteria, and related test instrument data used in the NDI/NDT process."

Guidance:

- When NDI/NDT is called out on a drawing or a specification. Examples include dye penetrant, X-ray, ultrasonic, PIND, eddy current, etc.

QC14a BUYERS REVIEW OF RADIOGRAPHIC FILM (NDT) REPORTS:

"Buyer's review and acceptance of radiographic inspection results is required at Seller's facility or other designated location prior to shipment of the contracted goods. Buyer's authorized purchasing representative will provide assistance and direction for coordinating this effort. If review and acceptance will be at Seller's facility, Seller will provide for reasonable facilities and assistance, including a suitable film review area (ref. MIL-STD-453). Evidence of Buyer's acceptance must be indicated on the applicable radiographic report or certification provided by the source performing the radiographic service".

Guidance:

- When NDI/NDT is called out on a drawing or a specification. Examples include dye penetrant, X-ray, ultrasonic, PIND, eddy current, etc.

QC15-N CRITICAL PROCESSES CERTIFICATION [NASA AQC12]:

"The following shall apply to customer designated 'critical processes' performed by the organization:

'The organization shall notify the customer of proposed changes in process definition and, shall obtain approval from the customer prior to implementing the change. Changes affecting processes, production equipment, tools and programs shall be documented. Procedures shall be available to control their implementation.'

The following shall apply to organization designated 'critical processes' that have been sub contracted:

'The supplier shall notify the organization of proposed changes in process definition and, shall obtain approval from the customer prior to implementing the change. Changes affecting processes, production equipment, tools and programs shall be documented. Procedures shall be available to control their implementation.'"

Guidance:

- Numerous processes performed to support build of flight hardware can have critical characteristics, and/or be considered a "special process".
- However, based on experience, knowledge, and risk considerations, some processes require an additional level of review and control. These are called Designated "Critical Processes"
- Designated "Critical Processes" are to be uniquely identified on the print, process specification or similar documentation and should be traceable to manufacturing operations.
- Designating a process as "critical" may drive cost and impact schedule and this designation should be reserved for those processes, which have been determined to have high risk and would benefit from such a designation.
- Use of this clause should be coordinated with the contractor prior to use.
- Critical processes performed by Organization's subcontractors shall be subject to QC 18-N (AQC04) Flow Down Requirements.

A Critical Process is defined as a process, which changes the chemical, structural, physical, safety, or performance characteristics or properties of a material. A treatment, process or procedure, which if improperly performed could have a significant performance effect on hardware.

QC15a USE OF CERTIFIED CRITICAL PROCESSOR (CCP) FROM JPL's ASL:

"Critical processes performed on this Contract/Purchase Order shall be performed by a processor on JPL's Approved Supplier List (ASL) listed as a Certified Critical Processor (CCP). Organization's responsibility for acceptable processing is not diminished by Organization's use of JPL's ASL CCP's."

Guidance:

- Numerous processes performed to support build of flight hardware can have critical characteristics, and/or be considered a "special process".
- However, based on experience, knowledge, and risk considerations, some processes require an additional level of review and control. These are called Designated "Critical Processes"
- Designated "Critical Processes" are to be uniquely identified on the print, process specification or similar documentation and should be traceable to manufacturing operations.
- Designating a process as "critical" may drive cost and impact schedule and this designation should be reserved for those processes, which have been determined to have high risk and would benefit from such a designation.
- Use of this clause should be coordinated with the contractor prior to use.
- This clause is used with QC15 to determine a critical process, and with QC17 to flow down the requirements to the certified critical processor.

- A **Critical Process** is defined as a process, which changes the chemical, structural, physical, safety, or performance characteristics or properties of a material. A treatment, process or procedure, which if improperly performed could have a significant performance effect on hardware.

QC16 PROCESS PROCEDURES (for non ISO system suppliers):

"Organization is required to have documented procedures that include process control procedures for all the hardware supplied under this Contract/Purchase Order. Procedures shall include detailed requirements for training and personnel certification, equipment validation, processing, documentation maintenance (including revision control), testing and inspection requirements, including inspection methods utilized and accept/reject criteria, and a system for nonconformance identification and control. These procedures are subject to inspection and approval by the JPL Procurement Quality Assurance Supplier Auditors."

Guidance:

- Use when an organization does not have a formalized ISO compliant quality system in place at the time of audit or P.O. issue.
- Use when an organization does not have a formalized AS 9100 compliant quality system in place at the time of audit or P.O. issue.
- Use when Quality Assurance is required with additional minimal documentation and quality provisions as specified in additional clauses and/or the S.O.W.

QC17 SUPPLIER (SUB-TIER) PROCESS CONTROLS:

"Organization is responsible for maintaining a system to control processes under this Contract/Purchase Order, not only at their facilities, but for processes performed at lower-tier suppliers (sub-tier) facilities. This clause mandates that all requirements, which are invoked or applied to the customer's purchasing document, including this clause, shall be flowed down to the organization's sub-tier suppliers.

Organization shall perform systematic, periodic evaluation of personnel, equipment, methods, and material required in the performance of the sub-tier supplier's processes to assure positive control at all times. Organization shall have a documented method of approving and maintaining sub-tier process suppliers that should include, on-site audits of subcontractors prior to initial performance of process activity, and periodically thereafter. JPL reserves the right to require JPL approval, perform surveillance and review, or audit, all aspects of the Organization and the Organization's lower-tier subcontract supplier's process activity and control system, prior to and during the period of performance of this Contract/Purchase Order."

Guidance:

- To assurance with minimum documentation and quality provisions as specified in additional clauses and/or the S.O.W. when work is flowed-down to a sub-tier supplier.
- This clause must be used with QC15N, which controls critical processes, and QC15a, which lists approved suppliers.

QC18-N FLOW DOWN REQUIREMENTS [NASA AQC04]

"This clause mandates that all applicable requirements that are invoked or applied to the customer's purchasing document, including this clause, shall be flowed down to the organization's sub-tier suppliers."

Guidance:

- This clause is imposed when a Quality system is not flowed down to the organization or the sub-tier supplier.
- The organization shall determine the applicable requirement for flow down based on the procured product, process or service.
- This requirement may be included as part of the contract terms and conditions.

QC19-N CHANGE CONTROL AUTHORITY [NASA AQC11]:

"The Organization shall provide in writing advance notification to the Customer of any change(s) to tooling, facilities, materials or processes at the Organization or the Organization's sub-tier that could affect the Customers contracted product. This includes, but is not limited to, fabrication, assembly, handling, testing, facility location or introduction of a new sub-tier supplier."

Guidance:

- This clause is used when any of the listed conditions are critical to product quality.
- This clause probably should be part of standard terms & conditions.
- This clause is used with QC18-N (AQC04) Flow Down Requirements to place this requirement on an organization's sub-tier suppliers.

QC20-N FIRST ARTICLE INSPECTION [NASA AQC15]:

"Organization is required to perform 100 percent inspection and record the attributes for the first article of this Contract/Purchase Order, and shall be in accordance with AS9100 and AS9102. If the deliverable is an assembly, this inspection shall also include all of the piece parts that make up the assembly. The inspection records and data shall be per AS9102 and shall identify each characteristic and feature required by design data, the allowable tolerance limits, and the actual dimension measured as objective evidence that each characteristic and feature has been inspected and accepted by the Organization's quality and inspection function. When testing is required, the parameters and results of the test shall be recorded in the same manner.

The First Article Inspection Report must show evidence of acceptance by the Organization's quality assurance representative. The First Article(s) shall be produced on production equipment and using processes which will be utilized on production runs.

Additionally, the Organization shall perform additional First Article Inspection(s) per the requirements of AS9102 (i.e.: following every major tooling, every design change, and subsequent to any evident quality degradation for a specified part or article).

Records of all first article activity will be documented as required in AS9102, treated as quality/acceptance records, and made available to Customer if requested."

QC20a DELIVERY OF FIRST ARTICLE INSPECTION RECORDS:

"The Organization shall provide one (1) reproducible copy of the First Article records and First Article Records Report accompanied by variables data with the initial shipment."

QC20b RETENTION OF FIRST ARTICLE:

"The Organization shall retain the first article(s) as objective evidence and make available to Customer upon request. Disposal of first article is prohibited until authorized by customer in writing."

QC20c DELIVERY OF FIRST ARTICLE:

"The Organization is required to deliver the first article to Customer for verification, as part of the Contract/Purchase Order, prior to the shipment of any balance of said Contract/Purchase Order, unless otherwise specified."

QC20d SOURCE INSPECTION OF FIRST ARTICLE:

"Customers' source inspection to witness the first article inspection, or specific details as specified in this Contract/Purchase Order."

Guidance:

>>> First article inspection is typically required for instances when a production run will be performed and not all articles will be fully inspected.

>>> For design development programs, such as build of a single spacecraft, the inspection, test, and engineering verification that is conducted during design development meets the intent of a first article inspection. For these types of activities this clause should not be used.

>>> If you are imposing a first article inspection clause, one or more of the following sub-clauses (QC20a-d) should be specified (reference AS 9102):

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

QC21 GENERAL INSPECTION OF RECEIVED SUB-COMPONENTS AND SUB-ASSEMBLIES:

"One hundred percent (100%) inspection is required unless JPL Procurement Quality Assurance has, previously approved a sampling plan, or a Statistical Process Control (SPC) Plan/Procedure(s). Organization and Organization's subcontractors shall generate and maintain records of all attribute and variables data of all inspections and tests performed. The records shall disclose the status of articles, the actual characteristics and features inspected, the allowable tolerance limits, tests and dates performed, and shall show objective evidence that each characteristic has been inspected and accepted by the Organization's quality representative. Additionally all Interface Control Dimensions (ICD) shall be inspected and actual dimension(s) shall be recorded."

Guidance:

- This might apply when purchasing machined parts to print, low volume, or when lot acceptance would not be applicable. Example: Typical report would be a Coordinate Measuring Machine (CMM) report.

QC21a-N INSPECTION AND TEST GENERAL CLAUSE [NASA AQC17]:

"The Organization shall submit (1) reproducible copy of all inspection documentation stamped by the responsible quality inspector showing 100% inspection for all attributes noted on the drawings, for all parts submitted under this Contract/Purchase Order."

Guidance:

- This might apply when purchasing machined parts to print, low volume, or when lot acceptance would not be applicable. Example: Typical report would be a CMM report.
- ***Use when an organization does not have a formalized ISO compliant quality system in place at the time of audit or P.O. issue.***
- ***Use when an organization does not have a formalized AS 9100 compliant quality system in place at the time of audit or P.O. issue.***
- ***Use when Assurance with minimum documentation and quality provisions is specified in additional clauses and/or the S.O.W.***
- ***Use when positive verification of attributes is required.***

Statements in bold italic letters were added because of JPL requirements.

QC22 OBJECTIVE EVIDENCE OF DIMENSIONAL INSPECTION:

"Organization shall provide objective evidence with each shipment that all the articles on this Contract/Purchase Order were dimensionally inspected for conformance with drawing and Contract/Purchase Order requirements. Objective evidence shall consist of records of actual dimensional readings taken during inspections, of each part, with the dimension and its tolerance noted.

All out of tolerance measurements shall be clearly identified on the records, and the disposition of that part noted by the Organizations quality assurance organization. This information is to be submitted to JPL for acceptance/rejection of the out-of-tolerance condition, prior to submittal of the hardware.

Organization shall identify each inspection data sheet to the related Contract/Purchase Order, part number, revision and when applicable, serial number. The management representative responsible for Organization's inspection activity, will certify that with signer's title and date of signature indicated that all of the shipped parts were indeed inspected to the criteria specified and those actual measurements are the one provided. If serial numbers are not assigned, then the supplier shall devise a method of linking the record of dimensional measurements with the specific part measured (i.e., taped, bagged together, etc.).

Inspection equipment (i.e.: tools & gages) used during dimensional measurement shall have its identification numbering recorded and have the ability to recall the parts inspected with that particular inspection device in the event it is subsequently found to be significantly out of tolerance."

Guidance:

- When in conjunction with first article inspection requirements (QC20)
- When objective evidence of dimensional inspection is required.
- When machining is to be completed at JPL or other process location.
- If not ISO or AS 9100 certified, invoke QC48

QC23 ACCEPTANCE TEST PROCEDURE DELIVERY FOR APPROVAL:

"Organization shall develop separate, detailed test procedures that encompass the final acceptance and verification requirements of the specifications of this Contract/Purchase Order. This Acceptance Test Procedure, and subsequent changes, shall be submitted to JPL for review and approval prior to use."

Guidance:

- If a finished or operational product is to be delivered from the organization, then an approved test plan shall be developed if not provided by JPL.
- When an organization -designed product is to be delivered, acceptance and test procedures may be part of the end item deliverable if JPL has not specified that JPL will design the procedure.
- May also apply to software deliverables.

QC24 QUALIFICATION TEST PROCEDURE:

"Organization shall develop and submit a detailed Qualification Test Procedure that encompasses all qualification requirements of the Product Requirements Specification for this Contract/Purchase Order. This Qualification Test Procedure and all subsequent changes shall be submitted to JPL for review and approval prior to use."

Guidance:

- If a finished or operational product is to be delivered from the organization, then an approved qualification test plan shall be developed, if not provided by JPL.
- When an organization-designed product is to be delivered, qualification acceptance and Qualification test procedures may be part of the end item deliverable, if JPL has not specified that JPL will design the procedure.
- May be included as the S.O.W. for some components or assemblies.
- May also apply to some software deliverables.

QC25 METALS CONTROL; SHEET, TUBE, ROLLED, WIRE OR OTHER FABRICATION:

"All metals submitted to JPL shall be certified per the appropriate ANSI, ASTM, AMS, MIL, or other standard or specification as applicable, to meet the specified Contract / Purchase Order requirements."

Guidance:

- Invoked on every purchase of metals.
- Combine with QC06-N (Certificate of Compliance) and QC06a (Traceability - Raw Materials) for any project use.
- For electrical wire and cable use QC07, instead of this clause.

QC25a WELD FILLER METAL CONTROL:

"The supplier shall submit the following: mill certification of the weld wire chemical analysis, identification (stamped, tagged, or equivalent) of alloy for each weld rod, and identification of manufacturer, heat lot number, size, weight, and specification material type on each container or reel/spool."

Sub-clauses for suppliers performing weld operations for JPL:

"(a) Prior to usage and when required by process or filler metal specification, applicable chemical, mechanical, weldability, etc., properties must be verified through tests on each shipment or lot (heat treat) of weld rod and reel/spool.

(b) Each weld rod shall be verified to be the specified material alloy prior to use. A unique identification must be place at the lowest level of control (i.e., wire, package, tube, etc.) to assure traceability of the 100% material alloy verification tests.

(c) Filler metals shall be stored in original sealed containers until immediately prior to use or test."

Guidance:

- Combine with QC06-N (Certificate of Compliance) and QC06a (Traceability - Raw Materials) for any purchase.
- May be combined with QC04 for test/specification certification requirements.

QC26-N SHIPPING DOCUMENTS [NASA AQC22]:

"Organization shall furnish Commercial Shipping Documents/Packing List, capable of being photographically reproducible through two additional reproductions, showing the following:

P.O. Number

Part Number(s)

Description

Qty ordered

Qty shipped

Lot/Date Code/serialization (as applicable)

Date of shipment

Any handling constraints or cautions such as, but not limited to:

- Optics; open only in clean room environments.
- ESD sensitive items, open only at approved ESD workstation.
- Moisture sensitive components, open/store only in humidity controlled area.
- Shock sensitive components (shock monitoring should be specified, if required.)"

Guidance:

- When this clause is specified, QC34-N (AQC20) Packaging Requirements clause is also needed.
- Consider special packaging requirements. This clause may also be imbedded in contract terms and conditions.

QC27 SOFTWARE QUALITY ASSURANCE:

"Organization shall implement a software development process in compliance with Doc ID 57653 Software Development (D-23713) and DocID 59952 Software Management Overview the JPL Design Principles for Flight Systems (D-17868) Appendix A. Organization shall provide JPL software planning documentation early in the formulation phase and artifacts at, or prior to, formal reviews to show compliance with JPL standards and the Organization's planning documentation."

Guidance:

- Use when procuring software, or software is an essential part of the operation, programming or verification of the component being procured.

QC28-N LIMITED OPERATING LIFE ITEMS [NASA AQC18]:

"Organization will collect and maintain records of operating time or cycles for all items designated as Limited Operating Life Items by Customer's drawings or specifications. Records will include the total elapsed time or cycle for each operation, cumulative time or cycles starting with the first functional test, and remaining time or cycles. A copy of this data will be included with each shipment traceable to the individual item by part number and serial number."

Guidance:

- Each procurement is to be reviewed to determine when data requirements for the status at time of delivery of accumulated operating time or cycle of parts designated as time or cycle critical is required. Examples are pressure vessels, flight connectors, batteries, mechanisms, and other similar items that have limitation on their operational use.
- Inclusion of the cycle time data record should be considered as part of the contract data item deliverable for the acceptance data package when the clause is imposed.

QC29-N QUALITY RECORDS RETENTION [NASA AQC25]:

"Organization and Organization's Subcontractors shall maintain verifiable objective evidence of all inspections and tests performed, results obtained and dispositions of non-conforming articles. These records shall be identified to associated articles, including heat lot and lot number of materials, unit or lot serialization and made available to Customer and/or Government Representatives upon request and shall be retained in a safe, accessible location for a period of ten (10) years after date of delivery as defined in the contract.

Organization's records associated with the manufacture of serialized or lot controlled articles will provide for continued traceability of serial numbers or lot number identification through all phases of manufacture, commencing with the raw material and continuing through final acceptance of the end item.

Records held for the required retention period (ten years) shall not be destroyed without Customer's written concurrence."

Guidance:

- This requirement shall be flowed down to all levels of configuration-managed items.
- Record retention is expensive, and use of this clause should be based on the future need of data retrieval, and the program risk associated with not having access to the documentation.
- The 10-year retention time has been identified as a default requirement based on the average life of spacecraft mission in operations (5-7 years). It recommended that 10 years be used in most application even for short duration missions, if it is anticipated that heritage information is necessary to support current and future missions (for example spare parts usage).
- If it is determined that 10 years is not the appropriate retention time based on mission design requirements, and/or operational results of the mission, then this should be communicated and the retention time adjusted accordingly.
- Data item deliverables for the contract should be reviewed to assure that verification data related to spare or unused parts is also addressed if it is anticipated that this data may be required at a later date. The inclusion of screening and qualification data with spare EEE parts is an example.

QC30-N CONFIGURATION MANAGEMENT SYSTEM (less than ISO 10007) [NASA AQC10]:

"Organization shall be responsible for controlling/tracking changes to parts and components manufactured to ensure that the end product meets specified design functional and physical characteristic requirements. This includes any part or component manufactured to Customers' or vendors' drawings, specifications, or special process procedures.

The organization and the customer shall document the agreements as to the extent of organization internal and formal customer involvement configuration management to be applied to this contract / purchase order.

At a minimum, with each shipment, Organization shall submit "configuration documents", which define the requirements, designs, build/production and verification for a configuration controlled item. This record shall be signed and dated by an official of the Organization's Quality Assurance department, and in addition to the aforementioned required information, shall include the following minimum requirements:

- Organization's Contract / Purchase Order number including any customer change orders
- Line item number
- Part number (Of deliverable item and all traceable/repairable sub-tiered parts)
- Serial number (traceability as required per contract/purchase order)
- Lot number (traceability as required per contract/purchase order)
- Drawing number (For Drawings related to deliverable item and all traceable/repairable sub-tiered parts)
- Revision level (baselined configuration of drawing to which hardware was built)
- Engineering order(s) (or equivalent drawing changes as applicable)
- Customer approved deviations and waivers (as applicable)

Guidance:

- Configuration management should be specified to the extent appropriate for the product and/or service being contracted. The main criterion is to select those items whose performance parameters and physical characteristics can be separately managed to achieve the overall end use performance of the item.
- Other selection criteria, which should be applied, are:

Criticality in terms of high risks, safety, mission success, etc:

New or modified technology, design or development;

Interfaces with other items;

Procurement conditions;

Logistic and maintenance aspects.

- For products and services involving detailed configuration control requirements the contract should specify implementation of a fully developed configuration management system, reference ISO 10007 as guidance.
- For products and services that do not require an extensive configuration management system the above noted clause should be used to define minimum configuration management requirements. Examples where this clause might be used in lieu of ISO 10007 guidance include prototype parts, non-critical/non flight hardware/software, COTS hardware/software, products/services provided by small suppliers.
- For products and service that involve software, configuration management requirements for software shall also be identified.

QC30a CONFIGURATION CONTROL, PRE-SUBMIT REQUIREMENT:

"Preliminary Parts List shall be delivered to JPL from contractor, and/or sub-contractor no later than 14 days prior to "Preliminary Design Review"(PDR)."

"As-Designed parts list shall be submitted to JPL from contractor, and / or sub-contractor no later than 30 days prior to project "Critical Design Review"(CDR)."

"As-Built parts list, with all changes from the As-Designed parts list highlighted, shall be delivered to JPL from contractor, and/or sub-contractor no later than 30 days prior to hardware delivery."

Guidance:

- Applied when design reviews will require the organization's CM verification per the Contract/Purchase Order requirements.
- Required number of days may vary based on project schedule or if otherwise scheduled by the S.O.W.

QC31-N EEE SINGLE LOT / DATE CODE [NASA AQC28]:

"The full quantity of date code controlled Electrical, Electronic, and Electromechanical (EEE) parts, each part number, provided under this Purchase Order/Contract must have a single lot-date code. The organization will obtain the written approval of the customer's authorized purchasing representative prior to shipping goods that do not meet this single lot/date code requirement.

In the event that the customer's purchasing representative provides said authorization to ship mixed lot/date codes, the organization shall provide a copy of the written authorization with the shipping document.

When mixed lot/date codes are authorized, the shipping document shall list individual lot/date codes and quantity. Multiple lot/date codes shall not be co-mingled. In addition, the individual part containers shall be marked with the quantity and lot/date code."

Guidance:

- This clause is applicable for procurements of lot number or date code controlled EEE parts that are subject to lot specific sample testing or require single lot traceability.
- Examples of EEE lot specific sample testing include, but is not limited to, Destructive Physical Analysis, radiation testing, and solder ability testing.
- For other parts that require general screening, such as visual inspection or Particle Impact Noise Detection (PIND) it may be advisable to implement this clause.

QC31a-N EEE PARTS DATE OF MANUFACTURE [NASA AQC27]:

"All Electrical, Electronic or Electromechanical (EEE) parts procured from the organization or its suppliers shall have been manufactured within three (3) years from the delivery date for Plastic Encapsulated Microcircuits (PEMs) and five (5) years for all others. This shall include all sub-assemblies of the article being procured.

Any deviation from this requirement shall be in the form of a written authorization from the procuring agency, and the authorization shall be included with each shipment."

Guidance:

- This clause applies primarily to flight and critical ground support equipment used for space mission where the part cannot be easily replaced and life is a consideration.
- This clause is applicable to EEE parts that are subject to degradation of performance or quality over extended periods of time and/or require traceability to the date of manufacture.
- Because of concerns about the solderability of connections this clause applies to most EEE parts.
- Special provision is made for PEMs in consideration of their non-hermetic construction and the risk of failure due to corrosion, and other construction-related weaknesses.
- There is no data item delivery associated with this clause, because the date of manufacture is usually marked on the part or packaging or accompanying documentation.

QC32 ACCEPTANCE DATA PACKAGE:

"Submit with each shipment of parts or assembly an acceptance data package consisting of all of the following as applicable (unless otherwise specified):

- Title Page
- Index
- Waiver/Deviation Record
- Shortages
- Open Work
- Deferred Operations
- Qualification Testing Reports of **QC24**
- Acceptance Test Reports of **QC23**
- Notes and Comments
- Material Review Board Actions
- Data requirements of **QC30"**

Guidance:

- When invoking this clause, verify that **QC23**, the ATP must be approved, **QC24,** the Qualification Test must be approved, and **QC30**, CM System information has been provided, are invoked if applicable.
- Required when the S.O.W. requires End-Item or Acceptance data package to be submitted for evaluation.
- Required when detailed or complex assemblies and/or sub-assemblies are purchased as completed units that have had, or require acceptance or qualification testing.

QC32a END ITEM DATA PACKAGE-DELIVERABLES TO ACCOMPANY PWB

In addition to the PWB's the following must be included in the delivery:
(Ref. D-8208, Sec. 3.6 and 3.7, Para 6.2)

- Microsections ("buttons") - the coupon set shall reflect the specific finished PWB characteristics. Both A and B coupons shall be submitted.
    - A (X-Direction) Thermal Stress
    - B (Y-Direction) Thermal Stress.

- Certification of Compliance-. Certification must contain the following:
    - Customer's Contract/Purchase Order number (JPL's)
    - Line number from the Contract/Purchase Order
    - Part number as identified in the Contract/Purchase Order
    - Name and address of manufacturing or processing location
    - Manufacturer's date code, lot number, and/or serial number/s
    - Quantity of boards.
    - Be signed and dated by an official of the company.

- All material certifications- The material used shall be traceable to the manufacturer's lot number through date code and serial number.
    - Organization shall include with each shipment the raw material manufacturer's test report (i.e., mill test report) that states that the lot of material furnished has been tested, inspected, and found to be in compliance with the applicable material specifications. Ref. QC06-N for further details.

- Copies of all inspection reports
    - Microsection evaluation results.
    - Results of all electrical verification testing performed at 200 Vdc.
    - Results of ionic contamination testing.

- Copies of any deviation reports-Any deviations or MRB action on the PWB's or constituent material

Guidance:

- Reference D-8208 Spacecraft Design & Fabrication Requirements (D-8208) latest revision released at time of procurement.

QC33 ACCEPTANCE DATA PACK – CRITICAL HARDWARE:

"Submit with each shipment of parts or assembly, an acceptance data package as defined in **QC32**, to include and define, any or all of the following as applicable:

- Limited Operating Life Items **(ref. QC28)**
- Limited Life and Age Controlled Items **(ref. QC12)**
- Nonstandard Calibration **(ref. QC08)**
- Repair Limitations
- Pressure Vessel Data **(ref. QC09)**
- Pyrotechnic Data
- Log Book
- Weight of Article
- Acceptance Test Data **(ref. QC32/QC33)**
- Drawing/Engineering Orders (Vendor Designs Only) **(ref. QC05)**
- Non-flight Hardware/Temporary Installations
- Software **(ref. QC27)"**

Guidance:

- Applied to hardware purchases, which if damaged, can have an adverse impact on the cost, schedules, or operability of JPL projects.
- Critical hardware may be defined as Flight, Flight Spare, Flight Back-up or critical G.S.E., for the purposes of this clause.

QC34-N PACKAGING REQUIREMENTS [NASA AQC20]:

"Organization's Quality Control organization shall be responsible for ensuring that items provided under this Contract/Purchase Order are packaged in such a manner that the dimensional integrity is preserved, contamination and corrosion are prevented, and no physical damage occurs or, when specified, that packaging is in accordance with the drawing, appropriate ASTM, MIL, or other applicable customer specified requirement."

Guidance:

- Packaging requirements must be appropriate to the value and configuration (i.e. physical fragility, size and shape) of each ordered item.
- Standard industrial practices are acceptable for low value/raw bulk or configured raw materials (i.e. pipe, bar stock, rod, etc).
- The manufacturer's packaging for commercial off-the-shelf (COTS) parts typically provide adequate protect for their product (e.g. computers, hand-held multimeters, test equipment).
- Special packaging shall be designated for electrostatic sensitive devices (ESD) and shall meet MIL-PRF-81705 requirements
- High-value and Build-To-Print items (i.e. electronic, electro-mechanical or optical) assemblies shall be packaged per Engineering design requirements if specified.
- Attention to ESD, foreign object damage (NAS412 Foreign Object Debris (FOD)) and physical integrity must also be noted for all products.

QC35-N ELECTROSTATIC DISCHARGE (ESD) PROTECTION PROGRAM AND PACKAGING [NASA AQC29]:

"The organization shall document and implement an ESD Control Program in accordance with ANSI/ESD S20.20, ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices). Parts must be properly packaged and identified as required in ANSI/ESD S20.20. All goods will be placed in conductive or static-dissipative packages, tubes, carriers, conductive bags, etc., for shipment. The packaging must be clearly labeled to indicate that it contains electrostatic sensitive goods and the level of sensitivity, if it is below 100 volts. Electrical parts that may be used or shipped in conjunction with ESD sensitive parts shall be treated as ESD sensitive."

Guidance:

- If you are receiving parts that are ESD sensitive that are being used in a critical application, then the organization providing the parts should have an ESD protection program in compliance with ANSI/ESD S20.20.
- Parts sensitive to voltages less than 100 volts (e.g., unprotected gate oxide devices) require additional controls beyond those specified in ANSI/ESD S20.20 (i.e., double bagging).
- When the part is being procured to an existing technical specification, it should be reviewed prior to applying this clause to ascertain the ESD control requirements imposed by the standard to determine if this clause is necessary.
- Some military specifications (i.e., MIL-PRF-55182) contain incomplete ESD control requirements that must be further specified by the purchaser. For resistors procured to military specifications, refer to MIL-DTL-39032, Table I, to determine if the resistor being procured is ESD sensitive (ESDS). For other parts, refer to the part specification.
- When the ESD sensitivity of a part or assembly is not known or not identified (e.g., inputs/outputs at black box level), the item shall be treated as ESD sensitive.
- A copy of the ESD control plan is not recommended for inclusion as a data item deliverable under the contract.

Note: This clause is applicable for procurement of ESD sensitive electrical piece parts excluding electrically initiated explosive devices.

QC36-N SOLVENT CONTAINERS [NASA AQC32]:

"All solvents must be supplied only in a new container that has not been used before to prevent contamination by residual material."

Guidance:

- Applies to all solvent purchase

QC37 MANUFACTURING PLANNING:

"Manufacturing planning and/or work instructions shall be used to control all manufacturing operations. Manufacturing planning and/or work instructions shall be available for JPL review and shall as a minimum include the following

- Full article identification and traceability to the said planning.
- The need for continuous hardware identification as to its inspection status.
- Material and parts to be used (Bill of Materials) to include parts identified as JPL furnished material.
- The specific operations, and order in which they are to be accomplished, if necessary.
- A list of all special process to be utilized during manufacture or testing.
- Traceability and recording requirements.
- Processes to be used, including procedure numbers with revision levels noted and recorded.
- List of required special tools and/or fixtures, to include accuracy requirements and calibration requirements and recordings.
- Identification of JPL furnished tools, fixtures or test equipment.
- Methods of hardware identification and/or serialization.
- The identification of all hazardous operations and the necessary precautions and controls to be utilized to minimize exposure.
- Organization inspection checkpoints with accept/reject criteria.
- Non-conformance recording and disposition.
- Any actual measurements that will be verified as part of the quality inspection acceptance.

Any attribute measurements that will be verified as part of the quality inspection acceptance."

Guidance:

- To be imposed when manufacturing planning is to be generated for a NON-ISO or NON-AS 9100 certified organization or their supplier.
- May be combined with several other applicable clauses based on the complexity of the planning required.

QC38 PYROTECHNIC DEVICE MANUFACTURING CONTROLS:

"For each production lot of each pyrotechnic device described by this Contract/Purchase Order, Organization shall make provision for the following reviews by Customer, as described below:

- Baseline Review (Phase I)
- Production Review (Phase II)
- Lot Certification Review (Phase III)

1. Baseline Review (Phase I)

   Organization shall begin fabrication of detail parts for a pyrotechnic device, only after Customer has established a hardware baseline for such device. The hardware baseline will be established through Customer's review, at Customer's plant, of Organization's drawings, specifications and related procurement, fabrication, processing, test and quality control procedures, as required by this Contract/Purchase Order, for a previously qualified device. Customer will accomplish this review 5 weeks after placement of this Contract/Purchase Order. For an unqualified device, Customer will accomplish this review 3 weeks after Critical Design Review.

2. Production Review (Phase II)

   Organization shall secure specific authorization from Customer prior to the explosive loading of any device. Organization shall give Customer at least two weeks prior notification, in writing, of the date on which explosive loading is scheduled to begin. Customer will schedule a review team to Organization's manufacturing facility for an on-site verification of Organization's implementation of quality system and hardware baseline requirements, and for a detailed correlation review of associated drawings, specifications, tooling, equipment, facilities, procedures, manufacturing environments, and personnel qualifications.

3. Lot Certification Review (Phase III)

   Organization shall receive specific authorization from Customer before shipping pyrotechnic devices under this Contract/Purchase Order. When Customer, at Customer's plant, determines that Organization's X-ray and N-ray films and associated data indicate an acceptable lot of pyrotechnic devices, Customer will schedule a lot certification review team visit to Organization's manufacturing facility. Customer's review team will perform an in-depth verification of Organization's supporting documentation and data required by Customer's Contract/Purchase Order prior to providing authorization to ship."

Guidance:

- Applies to all pyrotechnic procurements.

QC39-N NONCONFORMANCE REPORTING [NASA AQC23]:

"Under this clause, **Customer grants no MRB authority** to the Organization or it's sub-tier suppliers.

Repair is not allowed under this clause.

Definitions:

Nonconformance: A condition of any article, material or service in which one or more characteristics do not conform to requirements specified in the contract, drawings, specifications, or other approved product description. Includes failures, discrepancies, defects, anomalies, and malfunctions.

Rework: Used when an article can be made to conform to drawing requirements. Detailed instructions for rework must be included or referenced.

Repair: Used when the nonconforming article, material or service can be corrected to a usable condition, although its condition will not be identical with drawing / specification requirements.

The organization shall ensure that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. The controls and related responsibilities for dealing with nonconforming product shall be defined in a documented procedure.

The organization's documented procedure shall define the responsibility for review and authority for the disposition of nonconforming product and the process for approving personnel making these decisions.

Data Requirements: Any nonconformance discovered by the organization, on products in their control, shall be documented by the organizations' approved method of nonconformance reporting. This shall include a detailed description of the nonconformance; location (by drawing reference point, hardware reference point, clock location, etc.); and exact callout of the violation by drawing or specification requirement (including sub-paragraph or illustration number). It shall also list what type of test/inspection revealed the discrepant condition, and what, if any, subsequent actions were taken prior to disclosure. Dimensional violations shall include "should be" and "is" dimensions, and tool(s) calibration traceability numbers.

Nonconformance Preliminary Review: The preliminary review process shall be initiated with the identification and documentation of a nonconformance. A preliminary review shall be the initial step performed by the organization to determine if the nonconformance needs to be reported to the customer (see below), and to determine if the nonconformance is minor and can be re-worked to a condition that completely conforms to the drawing or specification requirements.

Note: Preliminary review does not negate the requirement to identify, segregate, document, and report and disposition nonconformances.

Nonconformances shall be reported to the customer under the following conditions. When notification is required, notification shall be within 3 working days after the nonconformance is discovered.

- The problem is detected during one of the following:
  1. Certification, acceptance, or qualification testing
  2. Other "significant" test as specified by the customer
  3. Turnaround, maintenance, overhaul, and repair of flight, ground test operation or shipping and receipt of hardware delivered to the customer including any test involving hardware previously accepted by the customer and returned for repair, modification, etc.
- And it is:
  1. Flight hardware
  2. Flight Hardware Spares
  3. Equipment that is representative of flight hardware (flight-like hardware), including prototype and qualification hardware
  4. Ground Support equipment (GSE) that is safety critical"

Guidance:

- Requirements for providing data on nonconformance should be specified as a data item deliverable. Where possible, use of an organization's internal tracking and reporting system should be considered.
- This clause is intended to address nonconformance reporting, and the fact that MRB is not being delegated.
- This clause would normally be used in a PO where flow down of a stand-alone problem reporting system requirement does not make sense (piece part or component level flight hardware or GSE fabrication).
- This clause is not intended to be used on major supplier contracts. Request for MRB authority should be reviewed on a case-by-case basis.

QC40 MATERIAL/PART MARKING REQUIRED FOR EACH ITEM:

"In addition to any other markings as required by part drawing and/or applicable specifications, Organization shall identify all procured items with the JPL part number or other part marking, as listed in this Contract/Purchase Order, utilizing the same method as required by part drawing and/or applicable specifications, or a means approved by the responsible JPL engineer in writing."

Guidance:

- Apply when the S.O.W. calls for specific re-identification to a specific JPL part number or other marking**.**
- Exact numbering to be marked should be called out in the purchase order or other document attached to the purchase order.

QC41 MATERIAL REVIEW BOARD (MRB) AUTHORITY GRANTED:

"Organization/Contractor is **granted MRB authority** for JPL procured articles delivered under this Contract/Purchase Order. Organization shall submit all MRB proceedings with all pertinent details and data related to the non-conformance to the JPL for concurrence within three days, and prior to implementation, if the disposition is anything other than "use as is", or "scrap".

The Contractor shall identify each nonconformance in a Material Review Board (MRB) proceeding, as a "Minor or Major Non-conformance". Major nonconformance is defined as affecting reliability, workmanship, performance, safety, interfaces or other approved JPL documentation. Minor non-conformances do not affect form, fit or function.

Submittal of a MRB concurrence does not guarantee, or obligate JPL to accept (concur) with the Organization's disposition, if JPL provides a rationale why concurrence is not granted for non-conforming procured items.

Organization shall process MRB proceedings in accordance with their established and approved Quality procedures."

Guidance:

- Applied when the organization is certified to ISO or AS9100 requirements, and has demonstrated, through auditing, that there is an adequate method of non-conformance identification, control and tracking, in addition to an established MRB procedure.
- Applicable only if MRB authority is delegated to the organization.

QC41a LIMITED MATERIAL REVIEW BOARD (MRB) AUTHORITY GRANTED:

"Organization/Contractor is **granted Limited MRB authority** for JPL procured articles delivered under this Contract/Purchase Order. Any nonconformance discovered by the organization, on products in their control, shall be documented by the organizations' approved method of nonconformance reporting, and reported to JPL within three days. Organization shall submit all MRB proceedings with all pertinent details and data related to the non-conformance to the JPL for concurrence within three days, and prior to implementation.

The Contractor shall identify each nonconformance in a Material Review Board (MRB) proceeding, as a "Minor or Major Non-conformance". Major nonconformance is defined as affecting reliability, workmanship, performance, safety, interfaces or other approved JPL documentation. Minor non-conformances do not affect form, fit or function.

Submittal of a MRB concurrence does not guarantee, or obligate JPL to accept (concur) with the Organization's disposition, if JPL provides a rationale why concurrence is not granted for non-conforming procured items.

Organization shall process MRB proceedings in accordance with their established and approved Quality procedures."

Guidance:

- Applied when the organization is certified to ISO or AS9100 requirements, but has demonstrated, through auditing, that there may not be an adequate method of non-conformance identification, control or tracking with an established MRB procedure.
- Applicable only if MRB authority is delegated to the organization.

QC42 CORRECTIVE ACTION:

"Organization shall have a documented corrective action mechanism in place as part of their quality program. As part of this mechanism, all discrepancies identified with JPL hardware or software, by either the Organization or JPL personnel shall be documented. All non-conformances will be tracked until resolution. Root causes shall be determined and preventative measures shall be implemented to prevent reoccurrence. Follow-up monitoring shall occur as validation.

All non-conformances relating to JPL hardware, software, test equipment or facility problems that could impact JPL deliverables, shall be *classified* as below, and shall be reported to JPL Quality Assurance within three days of occurrence.

Unless MRB authority has been delegated per **QC41**, Non-conformances that require the convening of a MRB shall be submitted to JPL per the requirements of **QC39**. The Organization will be directed of what specific action to take in reference to the MRB request. An MRB record, once disposition has been made shall be kept by the Organization as quality records and made available to the Customer upon request.

Class I changes: those that affect form, fit or function; affecting reliability, workmanship, performance, safety, interfaces or other approved JPL documentation shall be submitted for MRB disposition.

Class II changes: those that do not affect form, fit or function, and do not require submittal for MRB, shall be documented and submitted as part of the procurement End Item Data Package.

Submittal of a MRB request does not guarantee, or obligate JPL to accept (concur with) the Organization's disposition, or disposition non-conforming procured items for ultimate acceptance attempt, if JPL provides a rationale why concurrence is not granted."

Guidance:

- Applied in conjunction to QC39 or QC41.

QC43 CHEMICALS & MATERIAL SAFETY DATA SHEET (MSDS):

"Organization shall provide a reproducible copy of the MSDS with each shipment of any chemical, and for all hazardous or regulated materials.

All hazardous materials shall be packaged and shipped in accordance with the Code of Federal Regulations (CFR) 49.

In the case of certain hazardous or regulated materials, the detail specification shall take precedence over, or in concurrence with, this requirement."

Guidance:

- Required for all procurements of chemicals, regulated or hazardous materials.

QC44 USE OF JPL APPROVED SUPPLIER LIST (ASL):

"Organization certifies that all material and/or processing furnished by the Organization will be procured from a supplier or distributor listed in the JPL Approved Supplier List (ASL). Organization shall contact JPL procurement office in the event a supplier the organization wishes to utilize, is not on the ASL, and gain approval from the procurement office in writing prior to the use of the non-approved supplier"

Guidance:

- Applied if organization will procure additional materials, products or services from additional suppliers in the fulfillment of their Contract/Purchase Order.

QC45 JPL QUALITY ASSURANCE SITE REPRESENTATIVE ASSIGNMENT:

"JPL Quality Assurance will assign a site representative at Organization's facilities, either full time or on a schedule that is mutually acceptable to Customer and Organization. The Organization will provide suitable accommodations including as a minimum, a desk with suitable lighting, a working telephone, and if practical, a dial-up or other suitable Internet access line. The JPL site representative will participate in the planning and scheduling of the tasks to be performed, such as Design reviews, Hardware reviews, and Documentation reviews, including preliminary Material Review Board submittals, as specified in the statement of work for this Contract/Purchase Order.

Incorporate by reference JPL Quality Assurance Procedure – QAP 43.14"

Guidance:

- Invoked when a resident source inspector is expected to support project activity.
- Apply when mandated by S.O.W. requirements or Purchase Order requirements.

QC46-N JPL SOURCE INSPECTION [Modified NASA AQC14]:

JPL source inspection is required for all Mandatory Inspection Points (MIPs), and other times as required in the contract, prior to the shipment of articles from the Organization's facility. Upon receipt of this Order and prior to commencing work, Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593. The JPL PQA office requires a minimum number of working days advance notice prior to scheduling a date for the source inspection activity (see the chart below for required notice).

Source inspection shall be conducted by JPL at the Organization's facility, or other location where designated in the Contract/Purchase Order.

Organization shall make available to the JPL QA Representative all applicable purchase orders, drawings, specifications, procedures, statements of work, change orders, test software and changes thereto, related inspection and/or test equipment, and such other information, personnel and resources as may be required to satisfactorily perform the inspections and tests required under this Order. Organization shall ensure the current calibration and required accuracy of all instruments provided to the JPL QA representative accomplishing source inspection. The Organization shall provide a suitable workspace and environment in which to conduct the source inspection.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

Guidance:
>>> Invoked when a source inspection is required per the Contract/Purchase Order.

>>> When M.I.P's. have been applied to planning or the S.O.W.

>>> When the PEM or project CogE or QAE has determined that source

This clause is used with QC60 to determine and schedule MIPs, and QC47a to reinforce selection of specific MIPs.

QC47-N GOVERNMENT SOURCE INSPECTION (GSI) [NASA AQC13]:

"All work on this Purchase Contract is subject to inspection and test by the Government at any time and any place. Government inspection is required on this order prior to shipment from Organization's facility. Government inspections performed will be determined by the delegated Government inspection representative and may be conducted during processing, fabrication, or final inspection. Upon receipt of this Purchase Contract, promptly notify the Government representative who normally services your plant so that appropriate Government inspection planning can be accomplished. If your facility is not serviced by Government inspection and/or the area Government inspection representative or agency cannot be located, immediately notify Customer.

NOTE: Do not proceed with fabrication/manufacture processing until Government mandatory inspection points (GMIPs) are added to Organization's manufacturing planning. GMIPs shall not be by-passed unless authorized in writing by the Government inspection representative. Organization shall request and include the documents specified in the Government delegation, in the shipment.

The Government's request for source inspection shall specify the period and method for the advance notification and the Government representative to whom it shall be furnished. Request shall not require more then 2 workdays of advance notification if the Government representative is in residence in the Contractors plant, or more then 7 workdays in other instances.

Organization, without additional charge to the procurement document, shall provide all reasonably required facilities and assistance (applicable drawings, specifications, change orders, inspection and/or test equipment) for the US Government representative to perform their duties.

Organization shall ensure that Government inspection acceptance is evident for every individual GMIP and that completion of Government inspection is evident on Organization's shipping document/packing list. Evidence may be the signature of Government inspection representative with printed name and office, or application of the representative's stamp.

The Government shall accept or reject supplies as promptly as practical after delivery, unless otherwise provided in the contract. Government failure to inspect and accept or reject the supplies shall not relieve the Contractor from responsibility, nor impose liability on the Government, for nonconforming supplies.

When manufacturing processing affected by GMIPs is subcontracted by Organization, the provisions of this Clause shall be included in the Organization's Purchase Order verbatim."

Guidance:

- Each procurement situation should be evaluated based on the unique attributes involved. Decisions to specify Government Source Inspection (GSI) on contracts should include, but are not limited to the following considerations:
- Inspection Type: Supplies, Services, Research and Development, Construction
- Contract Type: (Fixed Price, Fixed-Price with Retroactive Price re-determination, Fixed-Price Incentive Based or Cost Reimbursement)
- Identification of Contract delivery Risks
- Analysis of each Risk Impact related to Safety, Cost, Schedule, and Performance

Support requirements, operating channels and procedures, and any other requirements must be thoroughly understood prior to transmitting official Letters of Delegation and/or task orders. The information provided within these requirements can apply to Safety and Mission Assurance (S&MA) for subcontracts as well as the prime contract. When there are multiple delegations and/or tasks (including those from other government locations) at a contractor's facility, duplication of effort must be eliminated where possible.

The following considerations should also be included when using the formal risk management process in planning the S&MA surveillance functions.

a. Contract, subcontract, and purchase order quality requirements.
b. End-use criticality of suppliers and services.
c. Current procedures and general operations, particularly those applicable to supplies and services similar to those being procured.
d. Technical direction to be given to the contractor.
e. Functions to be delegated or tasked and the performance desired.
f. Proposed support, including special skills.
g. S&MA functions to be accomplished at the contractor's facility by Government personnel.
h. Channels of communication.
i. Review of past S&MA history of the contractor, results of delegated agency S&MA program evaluation of the contractor and contractor's programs (quality assurance, risk management, etc.), known contractor's S&MA program deficiencies, and contractor's progress in correcting deficiencies.
j. Unique training and certification requirements.
k. Re-delegation and flow down of requirements (as applicable).

l. Interface situations arising from partial delegations or other delegations in the same facility.

m. Response time for mandatory inspections.

Reference FAR 46.3 and 46.4

http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/46.htm

This clause is used with QC46 (Modified AQC14) JPL Source Inspection to tell where and when to get source inspection of MIPs.

QC47a JPL MANDATORY INSPECTION POINTS:

"Inspection points shall be required where visual inspection access to hardware may be obscured by the next assembly task. These inspection points shall be inserted into the organizations shop planning or routing documents upon review by JPL project and quality representatives. This planning shall have on subsequent alteration by the organization without first obtaining approval from the JPL PQA liaison, and subsequent approval of planning changes post-revision.
Mandatory Inspection Points include, but are not limited to:

a. Precap Inspection of Integrated Circuits, hybrids, and other electronics."

Guidance:
>>> Invoked when a source inspection is required per the Contract/Purchase Order.

>>> When MIPs have been applied to planning or the S.O.W.

>>> When the PEM, project CogE or Q. A. representative has determined that source inspection of the hardware would be prudent.

This clause is used with QC60 to determine and schedule MIPs, and QC46 to tell where and when to get source inspection of MIPs.

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

QC47b PWB INNER LAYER AND FINAL SOURCE INSPECTION (JPL MIP)

The terms and conditions of this Quality Clause, becomes an integral part of the Purchase Order to the extent specified on the Purchase Order. Changes, additions, or deletions to the invoked Quality Clauses must be made by Purchase Order revision. Shipments will not be considered complete and invoices will not be honored until all requirements are fulfilled.

JPL QA Source Inspections *(Ref. D-8208, Sec. 3.6 and 3.7, Para 5.3.21)*
All flight PWBs shall have the following JPL QA source inspections:

- **Inner layer (I/L) Inspection; *(Ref. D-8208, Sec. 3.6 and 3.7, Para 5.3.5)***
  All inner layers shall be 100% inspected using AOI prior to the lamination process. This requirement may be waived at the discretion of the PWB Process Engineer and JPL QA. The waiver shall be in written form to the PWB vendor. It is highly preferred that the AOI machine be CAD-driven. All defective inner layers shall be discarded.

- **Final Inspection; *(Ref. D-8208, Sec. 3.6 and 3.7, Para 6.1.4.2)***
  JPL inspection of the finished (routed, tested, and inspected by the vendors final inspection process) PWBs shall be 100% of the manufactured lot. JPL QA shall also examine preselected microsections of both A and B coupons. Both As-Received and Thermal Stress microsections shall be examined. Both A and B microsections of the rigid portion of a PWB (in the case of a rigid flex PWB) and the flex portion shall be examined.

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

NOTES:

- Reference D-8208 Spacecraft Design & Fab Requirements (D-8208) latest revision released at time of procurement.
- Acceptance of hardware by JPL source inspector does not preclude subsequent rejection by JPL.
- In the event that the vendor has established that he or she cannot perform and deliver high quality PWBs in a timely manner as expected, the requirement of inner layer inspection may be waived by the JPL PWB Process Engineer and project QAE.

Guidance:

- To be invoked on all procurements for flight and critical ground support equipment PWBs
- Source Inspection is not applicable to COTS PWB's

QC47c PRE-CAP INSPECTION ON ELECTRONIC PARTS (JPL MIP)

"Inspection points shall be required where visual inspection access to hardware may be obscured by the next assembly task. These inspection points shall be inserted into the Organization's shop planning or routing documents upon review by JPL project and quality representatives. This planning shall have no subsequent alteration by the Organization without first obtaining approval from the JPL PQA liaison, and subsequent approval of planning changes post-revision.

Pre-cap visual inspection shall be performed by JPL's Procurement Quality Assurance organization on all packaged flight Application Specific Integrated Circuits (ASICs), hybrid microcircuits, Multi-Chip Modules (MCMs), crystal oscillators and non-standard relays.

Hybrid flight lots shall be subjected to 100% source inspection. The source inspection team shall include JPL representatives.

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

Guidance:
Invoked when a source inspection is required per the Contract/Purchase Order.
>>> When MIP's have been applied to planning or the Statement of Work (SOW).
>>> When the Project Element Manager (PEM), Project Cognizant Engineer (CogE) or Quality Assurance (QA) representative has determined that source inspection of the hardware is required.

This clause is used with QC46-N to tell where and when to get source inspection of MIP's. It may also be used with QC60 to determine and schedule MIP's.

QC47d IN-PROCESS INSPECTION (JPL MIP)

Inspection points shall be required where visual inspection access to hardware may be obscured by the next assembly task. These inspection points shall be inserted into the organization's shop planning or routing documents upon review by JPL project and quality representatives. This planning shall have no subsequent alteration by the organization without first obtaining approval from the JPL PQA liaison, and subsequent approval of planning changes post-revision.
Mandatory Inspection Points may include, but are not limited to:

- Internal wiring of electric motors
- Surface finishes prior to next-step assembly operations
- Close tolerance dimensions before or after special plating processes
- Printed Wiring Assemblies (PWAs) prior to conformal coat.
- Optics prior to coating.

The Organization shall access http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm to request source. As a last resort, the Organization may call the JPL Source Inspection line at (818)393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

QC47e FINAL INSPECTION (JPL MIP)

A final inspection shall be performed by JPL source inspection prior to shipment of product from Organization's facility.

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

QC48 JPL TEST WITNESS SOURCE INSPECTION IS REQUIRED

JPL Test Witnessing is required for any or all of the following: acceptance tests, qualification tests, environmental tests, and nondestructive tests performed on items delivered under this Contract/Purchase Order. Other tests requiring a JPL witness may be listed in a Statement of Work accompanying the Contract/Purchase Order.
JPL source test verification is required for first article final electrical (Functional Test) and other times as required in the contract, prior to the shipment of articles from the Organization's facility.

Organization shall promptly notify the JPL Procurement Quality Assurance (PQA) office at http://eis.jpl.nasa.gov/qa/PQA/servicerequest.cfm so the appropriate inspection can be coordinated. The following phone number may be accessed if necessary: (818) 393-7593.

Test witness source inspection shall be conducted by JPL at the Organization's facility, or other location where designated in the Contract/Purchase Order. Organization shall make available to the JPL QA Representative all applicable purchase orders, drawings, specifications, and changes thereto, related test procedures, inspection and/or test equipment, and such other information, personnel and resources as may be required to satisfactorily perform the inspections and tests required under this Order. Organization shall ensure the current calibration and required accuracy of all instruments provided to the JPL QA representative accomplishing the test witness source inspection. The Organization shall provide a suitable workspace and environment in which to conduct the source inspection.

Guidance:
>>> Invoked when a source inspection is required per the Contract/Purchase Order.
>>> When M.I.P's. have been applied to planning or the S.O.W.
>>> When the PEM or project CogE has determined that source inspection of the hardware would be prudent.

Locale	Business days advance notice	Notes
Local: In-state	3 days	Minimum required
National: Domestic	5 days	Minimum required
International	10 days	Long lead time/forecasting desired

QC49-N CALIBRATION SYSTEM REQUIREMENT (for non ISO compliant or AS 9100 certified suppliers) [NASA AQC09]:

"The organization shall have a documented calibration system that meets the requirements of the "American National Standard Institute (ANSI)/National Conference of Standards Laboratories (NCSL) Z540-1, General Requirements for Calibration Laboratories and Measuring and Test Equipment."

Guidance:

- This clause shall be imposed to assure the organization has a compliant calibration system in place to control and validate measuring and test equipment used to assure deliverables meet prescribed customer requirements.

QC50 ORGANIZATION INSPECTION REQUIREMENTS (non-flight or non-critical GSE hardware):

"Organization will maintain a system in place, which shall include provisions for defining and verifying articles and material quality through all operations, including procurement, fabrication, testing and delivery, and shall comply with ISO 9000-2000 or AS 9100, Inspection System Requirements or equivalent. If unsatisfactory conditions are discovered they shall be promptly corrected.

Items shall be clearly marked, labeled or tagged in such a manner that objective identification can be determined upon receipt, unless otherwise specified in this Order.

When requested by Customer, Organization shall provide reproducible copies of drawings, catalog cuts, brochures, etc., which can be utilized to assure compliance with advertised requirements.

If Organization is not the manufacturer, Organization shall furnish goods, which have been obtained from a source approved by Customer, as well as provide the name and address of the manufacturer on the shipping report or applicable certification.

Incorporate by reference **QC44**. Customer's authorized purchasing representative will furnish a list of approved sources (ASL).

Incorporate by reference **QC18**. Organization shall insert the substance of this clause, including this sentence, in all lower-tier subcontracts for work done under this contract. "

Guidance:

- Applies to a Non-certified organization that must still maintain a quality system for Inspection and non-conformance control.
- May apply to distributors, catalog company orders, resellers of commercial products, etc.
- QC44 and QC17 are always included with this clause.

QC51 NSTS 5300.4 (CURRENT REV.) INSPECTION SYSTEM:

"Organization shall establish and maintain an inspection system in accordance with the above listed NASA Document, *"Safety, Reliability, Maintainability, and Quality Provisions for Space Shuttle Program"*. Organization will invoke that equivalent Inspection System on Organization's Suppliers as appropriate and to the extent necessary to ensure the required quality of purchased materials, parts and components. Organization is not required to submit an inspection system plan unless requested by JPL. If a documented quality plan is required it will be requested as specified in **QC53.**

Customer reserves the right to perform periodic audits at Organization's facility."

Guidance:

- Applies to a Non-certified organization that must still maintain a quality system for Inspection and non-conformance control.
- May apply to distributors, catalog company orders, resellers of commercial products, etc.

QC52-N QUALITY MANAGEMENT SYSTEM [NASA AQC02]:

When Specifying Compliance to **AS 9100**:

"The organization shall have a quality program that complies with Society of Automotive Engineers International (SAE) document AS 9100 - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing."

Third party certification / registration is not required. *****

When Specifying Compliance to **ISO 9001:2000:**

"The organization shall have a quality program that complies with International Organization for Standardization document ISO 9001 - Quality Management Systems -- Requirements."

Third party certification / registration is not required. *****

When Awarding a Contract to an ISO or AS9100 Registered Organization***:***

"If Customer has accepted Organization's third party quality registration and Organization subsequently changes registrars, loses its registration status, or is put on notice of losing its registration status, it shall notify Customer's procuring Component(s) within three days of receiving such notice from its registrar."

**** JPL will, on request of Procurement, provide ISO registered auditors to verify ISO compliance.***

Guidance:

- For organizations designing, manufacturing, and/or conducting critical ground and/or flight operations of space flight components, sub-assemblies, and assemblies the provisions of AS9100 should be used.
- For organizations providing support services that could affect the mission success of a program or mission ISO 9001:2000 should be used.
- For organizations providing piece parts, and/or individual items manufactured to a specification/standard, necessary provision shall be individually established to assure the quality of the product that is received.
- This requirement may be included as part of the contract terms and conditions.

Statements in bold italic letters were added because of JPL requirements.

QC53 INSPECTION SYSTEM PLAN:

"The Organization shall prepare and submit for Customer approval an inspection system plan for the test and inspection of articles under this Contract/Purchase Order. The inspection system plan shall cover activities for the Contract/Purchase Order period and be tailored to the Contract/Purchase Order requirements. The plan shall also describe the Organization's overall implementation of the inspection system requirements of the imposed quality inspection system and shall include the following provisions:

a. Include an organization chart showing each element of the quality organization and its relation to the entire organization.

b. A narrative description of the Organization's existing system for implementing quality provisions, including proposed changes to the existing system needed to meet cited provisions, and the time schedule for implementing such changes.

c. Arrange the plan in the same sequence as the imposed quality inspection system, or include a suitable cross-reference chart.

d. Describe the method for assuring that the latest applicable or imposed drawings, specifications, and procedures, as well as authorized changes thereto, are used for manufacturing, processing, and/or testing article on this Contract/Purchase Order.

e. List controlling documents, applicable drawings, specifications and procedures to be utilized in the performance of this Contract/Purchase Order

f. Reference to the Organization's quality documents shall be utilized in meeting the quality inspection system provisions.

g. Design the plan to assure that article under this Contract/Purchase Order, and the associated data submitted to the Customer for acceptance, conforms to the Contract/Purchase Order requirements, whether manufactured of processed by the Organization, or procured from subcontractors.

h. Describe or reference the procedure for documenting and reporting nonconforming conditions, including test failures, and method of assuring positive corrective action is implemented and monitored, to prevent future occurrences.

i. Provide charts indicating the flow of articles and materials from receiving through fabrication operations, test and/or delivery.

j. Describe the method of assuring applicable quality requirements are imposed to subcontractors for fabrication and/or processing including processes designated as critical per this Contract/Purchase Order."

Guidance:

- If a Contract/Purchase Order is issued ahead of the initial Audit for compliance with ISO or AS 9100 requirements, the quality system must be in place via invocation of this clause.
- When a supplier is not in compliance with ISO or AS requirements, but a Quality system is required for risk mitigation.
- When there has been degradation in the supplier's quality performance rating, and corrective action has not yet been validated as effective.

This clause is used with QC30 to establish a minimum Configuration Management system.

QC54 ORGANIZATIONS GENERAL QUALITY ASSURANCE SYSTEM REQUIREMENTS FOR MAINTENANCE:

"Organization shall maintain the quality system approved by the Customer at the time of survey or Contract/Purchase Order placement. Customer reserves the right to perform audits or inspections at Organization's facility to determine compliance with the approved quality system.

The Organization/Contractor shall be responsible for the Safety and Quality Assurance of all contracted work. JPL will monitor and verify all work performed is in satisfactory compliance with applicable standards, and in accordance with the Contract /Purchase order requirements.

JPL/Customer reserves the right to:

1. Inspect the contractor's facility to ensure the contractor has the capability, tools, equipment, and spare parts to perform the work specified in the purchase order/contract;
2. Audit the contractor's Quality Assurance Program to verify its compliance with purchase order/contract requirements;
3. Take photographs as deemed appropriate during the manufacturing, inspection, or testing process;
4. Inspect all work being performed under this contract at the contractor's facility, the contractor's sub-tier suppliers, or at JPL."

Guidance:

- To assure continued maintenance and compliance with the quality system in place at the time of facility audit.
- May be used if the need is present to perform interim inspections to verify conformance.
- Will be combined with QC55-QC59 (depending on the procurement) if the organization is not an ISO or AS certified organization.

QC55 LEVEL 1 QUALITY SYSTEM: QUALITY SYSTEM REQUIREMENTS FOR ORGANIZATIONS WHO DESIGN AND BUILD FLIGHT HARDWARE AND GROUND SUPPORT EQUIPMENT TO PROCUREMENT SPECIFICATIONS:

"Organization will establish and maintain a quality assurance system that provides the level of quality necessary to deliver or provide the stated articles or service.

The provisions of this document shall satisfy the requirements for Organization designed Flight and/or Ground hardware or Systems with performance requirements supplied by Customer.

Organization's quality plan, when defined in the form of a quality table, shall be submitted and approved by Customer prior to commencing any fabrication. Customer reserves the right to perform periodic audits at Organization's facility.

Include by reference **QC54.**"

Guidance:

- When the organization is not an ISO or AS certified supplier, and they are supplying Organization designed Flight and/or Ground hardware or Systems with performance requirements supplied by Customer.
- Combine with **QC54** Organizations General Quality Assurance System Requirements for Maintenance.

QC56 LEVEL 2 QUALITY SYSTEM: QUALITY SYSTEM REQUIREMENTS FOR ORGANIZATIONS WHO BUILD FLIGHT HARDWARE AND TYPE I GROUND SUPPORT EQUIPMENT TO PROCUREMENT SPECIFICATIONS:

"Organization will establish and maintain a quality assurance system that provides the level of quality necessary to deliver or provide the stated articles or service.

The provisions of this document shall satisfy the requirements for Organization designed Flight and/or Ground hardware and Systems where Customer specifies an acceptance criterion.

Organization's quality plan, when defined in the form of a quality table, shall be submitted and approved by Customer prior to commencing any fabrication. Customer reserves the right to perform periodic audits at Organization's facility.

Include by reference **QC54.**"

Guidance:

- When the organization is not an ISO or AS certified supplier, and they are supplying Organization designed Flight and/or Ground hardware and Systems where Customer specifies an acceptance criterion.
- Combine with **QC54** Organizations General Quality Assurance System Requirements for Maintenance.

QC57 LEVEL 3 QUALITY SYSTEM: QUALITY SYSTEM REQUIREMENTS FOR ORGANIZATIONS WHO MODIFY FLIGHT HARDWARE & GROUND SUPPORT EQUIPMENT TO PROCUREMENT SPECIFICATIONS:

"Organization will establish and maintain a quality assurance system that provides the level of quality necessary to deliver or provide the stated articles or service.

The provisions of this document shall satisfy the requirements for Organization designed Flight and/or Ground hardware and Systems, where basic hardware usage remains unchanged, but delta qualification or re-qualification testing is a consideration for certification purposes as specified by Customer.

Organization's quality plan, when defined in the form of a quality table, shall be submitted and approved by Customer prior to commencing any fabrication. Customer reserves the right to perform periodic audits at Organization's facility.

Include by reference **QC54.**"

Guidance:

- When the organization is not an ISO or AS certified supplier, and they are supplying Organization designed Flight and/or Ground hardware or Systems where basic hardware usage remains unchanged, but delta qualification or re-qualification testing is a consideration for certification purposes as specified by Customer.
- Combine with **QC54** Organizations General Quality Assurance System Requirements for Maintenance.

QC58 LEVEL 4 QUALITY SYSTEM: QUALITY SYSTEM REQUIREMENTS FOR ORGANIZATIONS WHO PROVIDE COMMERCIAL ARTICLES:

"Organization will establish and maintain a quality assurance system that provides the level of quality necessary to deliver or provide the stated articles or service. The provisions of this document shall satisfy the requirements for Organization designed commercial hardware controlled by Customer specifications. Organization's quality plan, when defined in the form of a quality table, shall be submitted and approved by Customer prior to commencing any fabrication. Customer reserves the right to perform periodic audits at Organization's facility.

Include by reference **QC54.**"

Guidance:

- When the organization is not an ISO or AS certified supplier, and they are supplying Organization designed commercial hardware controlled by Customer specifications.
- Combine with **QC54** Organizations General Quality Assurance System Requirements for Maintenance.

QC59 LEVEL 5 QUALITY SYSTEM: QUALITY SYSTEM REQUIREMENTS FOR ORGANIZATIONS WHO PROVIDE COMMERCIAL OFF-THE-SHELF ARTICLES.

"Organization will establish and maintain a quality assurance system that provides the level of quality necessary to deliver or provide the stated articles or service.

The provisions of this document shall satisfy the requirements for Commercial Off-the Shelf (COTS) Vendor designed commercial hardware controlled by Customer specifications. Hardware shall be considered non-critical, and totally capable of being inspected, as said hardware may be subjected to additional screening once received by JPL. Customer reserves the right to perform periodic audits at Organization's facility.

Include by reference **QC54.**"

Guidance:

- When the organization is not an ISO or AS certified supplier, and they are supplying Commercial Off-the Shelf (COTS) Vendor designed commercial hardware controlled by Customer specifications.
- Combine with **QC54** Organizations General Quality Assurance System Requirements for Maintenance.

QC60 SUBMISSION AND APPROVAL OF FLOWCHART(s):

"The organization shall provide a block type flow chart for all significant steps in the fabrication of the hardware, software or service specified in the contract/purchase order. This document can be furnished ether electronically or as hardcopy. This flow chart shall include all applicable steps including, but not limited to the following

- Engineering
- Design reviews
- Source selection
- Source qualification
- Receiving inspection,
- Kiting
- Manufacturing,
- Assembly
- Out-sourced special processes
- Materials processing
- In process inspection
- First article, incremental testing, final testing
- Validation, final inspection, marking, packaging
- Shipping and storage

Each block shall be briefly, but clearly labeled as to the step being preformed. More than one flow chart may be necessary to include all significant steps and all identified deliverables. This flow chart is to be signed by the appropriate Quality representative with the authority to make changes as needed.

This flow chart will be reviewed and approved by a representative from the JPL Procurement Quality Assurance office. It may be changed to add JPL identified Mandatory Inspection Points (MIP's). After signing an approval block this flow will be returned to become part of the required documentation for this contract/purchase order and be considered the approved flow chart. Any subsequent changes will require concurrence and re-approval by all parties to the original approval."

Guidance:

- Applicable when the manufacturing process is complicated enough to warrant an operational manufacturing process flow.
- May be applicable for simple manufacturing process in lieu of detailed planning operations depicting movement through the process, but it cannot be used in lieu of detailed planning instructions.
- Software flow charts may be provided with a Software Development Plan, or it's equivalent.

This clause is used with QC47a to reinforce selection of specific MIPs, and QC46 to tell where and when to get source inspection of MIPs.

QC61 OXYGEN COMPATIBILITY TESTING:

"Material(s) on this Contract / Purchase Order require oxygen compatibility batch/lot testing per applicable specifications. Oxygen compatibility batch/lot testing will be performed by Customer on required specimens submitted by Organization for fluorocarbon plastics and elastomers, dry film lubricants, and Teflon coatings. Batch / lot testing approval must be obtained prior to manufacture / process of articles.

Organization shall furnish batch / lot number and applicable test report number and results with each shipment of articles to Customer

If materials on this Purchase Contract are furnished by JPL, supplier shall furnish with each shipment of articles, a copy of applicable JPL shipping document, and a certifying statement attesting that articles were manufactured using material furnished on the said document."

Guidance:

- Applicable whenever Oxygen compatibility may be present or in contact with the hardware.

QC62 MANUFACTURER'S COMMERCIAL AND GOVERNMENT ENTITY (CAGE) CODE:

The Organization will provide, with each shipment, the Manufacturer or Service Provider's Commercial and Government Entity (CAGE) Code. The Organization will legibly identify and record the CAGE Code on the documentation to be supplied to the Customer *(i.e., shipping documents, certification(s), data packages, etc)*. If, at the time of the purchase/subcontract acceptance, the Organization does not have a CAGE Code, the Organization has 30 days to register for a CAGE Code and provide it to JPL's Procurement Quality Assurance Group by calling the Supplier Information Line at 818-393-7592.

Failure to register for a CAGE Code will cause an automatic Withheld classification in JPL's Approved Supplier List (ASL), unless a request for an extension is received. A Withheld classification requires that the Jet Propulsion Laboratory place no new procurements with your company, for products and/or services for JPL Flight/Critical Items.

GUIDANCE:

> This Quality Clause is applicable to all procurement vehicles used to purchase products and/or services for JPL a) Flight Hardware or Software, b) R&D/Prototype with Flight potential, and other c) JPL Critical Items/Ground Support.

A CAGE Code is a five (5)-position code that identifies companies doing or wishing to do business with the Federal Government. The code is used to support a variety of mechanized systems throughout the government. The code provides for a standardized method of identifying a given facility at a specific location. The code may be used for a Facility Clearance, a Pre-Award survey, automated Bidders Lists, pay processes, source of supply, etc. In some cases, prime contractors may require their sub-contractors to have a CAGE Code also.
The CAGE system validates all Central Contractor Registration (CCR) registrants. If you have a CAGE Code, it will be identified and applied to your Trading Partner Profile (TPP). If you do not have a CAGE Code you can register in CCR at https://www.bpn.gov/ccr/scripts/index.html or call for assistance at 1-888-227-2423.

The Defense Logistics Information Service (DLIS) in Battle Creek, MI is the only authorized source of CAGE Codes. More information can be found on the DLIS website at: http://www.dlis.dla.mil/cage_welcome.asp

QC63-N RIGHT OF ACCESS [NASA AQC03]:

"Work under this purchase order/contract is subject to government or customer surveillance/inspection at organization's plant or sub-tier supplier's facility. The organization will be notified if a surveillance/inspection is to be conducted."

Guidance:

- To be used when source inspection has not been specified. No shipments are to be held for government or customer inspection unless notification is received by the organization prior to shipment.
- Ref: FAR Section 46.
- http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/46.htm
- This requirement may be included as part of the contract terms and conditions.

QC64-N GIDEP ALERT AND PROBLEM ADVISORIES [NASA AQC24]:

"The contractor shall participate in the Government-Industry Data Exchange Program (GIDEP) in accordance with the requirements of the GIDEP S0300- BT-PRO-010 and S0300-BU-GYD-010, available from the GIDEP Operations Center, PO Box 8000, Corona, California 91718-8000. The contractor shall review all GIDEP ALERTS, GIDEP SAFE-ALERTS, GIDEP Problem Advisories, GIDEP Agency Action Notices, and NASA Advisories to determine if they affect the contractors products/services provided to NASA. For those that affect the program, the contractor shall take action to eliminate or mitigate any negative effect to an acceptable level. The contractor shall generate the appropriate failure experience data report(s) (GIDEP ALERT, GIDEP SAFE-ALERT, GIDEP Problem Advisory) whenever failed or nonconforming items, available to other buyers, are discovered during the course of the contract."

Guidance:

Each procurement is to be reviewed to determine if participation in the Government-Industry Data Exchange Program (GIDEP) and NASA Advisory Program (NAP) is appropriate. The following factors should be considered in this determination:

- Type of Procurement - consider the commodity being purchased; generally contracts involving the manufacturing, distribution, test, and/or operations of critical/complex space flight related hardware/software product or services should require GIDEP reporting. Other types of activities, such as an administrative service support contract, do not require GIDEP reporting.
- Acquisition Phase - consider the phase of the program and the utility of the GIDEP and NASA Advisory data to support that phase, generally activities after the conceptual design phase can benefit most from participation.
- Dollar Value of Contract - consider the amount of the contract and the benefit to be obtained from participation or the risks of not participating. There is no cost to contractors to participate in GIDEP - There is a cost to review and evaluate information.
- Prime contractors often have internal alert systems that provide equivalent exchange of information. Under these circumstances the prime is responsible for flow – down of the equivalent reporting requirements to applicable sub-tier suppliers, and for assuring sub-tier supplier compliance with the requirements.

QC65-N SPECIAL PROCESS CERTIFICATION [NASA AQC08]:

"Certain special processes are required to comply with this contract. Special processes shall be performed only by sources that have been surveyed and qualified / approved, by the supplier and / or the Customer, to perform those processes. The contractor shall provide to the Customer upon request all documentation showing evidence of special processor qualification and/or certification to perform special manufacturing, assembling, and test processing as required by the contract. Organization may elect to use only Customer approved sources.

A special process certification shall be provided with each shipment of item(s) delivered on this contract. Special Process Certifications may be in supplier format and shall include the following:

- Customer's Order number
- Part number(s)
- Serial and/or lot numbers, of the hardware processed (if applicable,)
- Material process specification & revision
- Objective evidence demonstrating compliance with the applicable process, (i.e. temperature charts and Hardness test results for heat treatment, destructive test results, etc.)
- A certification stating the special process was performed per the applicable drawing/specification requirements.
- Organization 's name and address

When special processor is other than the Organization, provide a certification of compliance from the special processor stating the special process was performed per the applicable drawing/specification requirements. Certifications must include the processor's name, address and be signed and dated by a company official.

Each certification must be signed and dated by a company official of the Organization and/or Processor attesting to the acceptance of the processes performed to the required specification(s).

The supplier shall retain all records associated with the selection and approval of supplier approved special process providers. Per contract or regulatory agency requirements, these records shall be made available to the Customer and/or regulatory agencies upon request. The supplier shall notify the Customer prior to destruction of records relative to this contract.

The Organization shall insert the substance of this clause, including this sentence, in all lower-tier subcontracts for work performed under this contract."

Guidance:

- "**Special Processes**" is defined as any process for production and service provision where subsequent monitoring or measurement cannot verify the resulting output. This includes any process where deficiencies become apparent only after the product is in use or the service has been delivered. Examples may include, but are not limited to, Heat Treat, Non Destructive Test, chemical or metallic coatings (e.g.: anodize, passivation), welding, unique or uncommon processes.
- The organization may elect to impose the following additional requirement within their flow-down contracts:

"When imposed elsewhere within the contract, only Customer approved Processor(s) shall perform certain special processes. A list of Customer approved processors is available from Customer's authorized purchasing / subcontract representative. Processors not listed in the Customer approved processors list must be surveyed and approved by Customer prior to performance of the process. Requests for processor surveys will be submitted to Customer's authorized purchasing / subcontract representative."

QC66 HANDLING OF BERYLLIUM:

"Identification of any AlBeMet or Beryllium containing part or product

"If a part containing Beryllium is received on-Lab, it shall be identified as such on it and all the paperwork, and shall indicate that fabricating or modifying this Beryllium is hazardous. Due to the limitations on what can be stamped on a relatively small product or part, the warning note for Beryllium has been devised as stated below.

All AlBeMet and Beryllium-containing parts, drawings, travelers, and containers shall be RED ink stamped with the following warning note:

'DANGER—BERYLLIUM ALLOY

TOXIC WHEN MACHINED'

The container shall be marked: "Open in a glove box or clean room."

Identification of any AlBeMet or Beryllium-containing part or product on Drawings

"A drawing shall indicate the location of the AlBeMet or Beryllium part or component and shall include the following:

'Danger: This part is an AlBeMet/Beryllium Alloy (Beryllium) part. Do not fabricate or modify. Fabricating or modifying this material will pose a serious safety and health hazard, if dusts or fumes are generated. No fabrication or modification at JPL is allowed without approval by the responsible supervisor and the JPL Industrial Hygiene Office. See the Material Safety Data Sheet (MSDS) and contact the JPL Industrial Hygiene Office, for additional information.'"

Requirements on any Organization fabricating or modifying a Beryllium or Beryllium containing part:

"The organization shall have facilities for the fabrication or modification of Beryllium or Beryllium containing parts. These facilities shall meet the OSHA requirements for dust and fume containment and cleaning of the parts."

Guidance:

- This is currently a placeholder. A clause is being drafted which imposes strict OSHA requirements for containment and dust free parts on the organization.
- Due to the inherent and severe hazards related to exposure of Beryllium and

Beryllium alloy dusts and fumes, JPL out sources the fabrication and modification of any Beryllium containing components.

- If an AlBeMet, Beryllium Copper or Beryllium-containing part must be modified or fabricated, it can only be performed after the approval of the responsible supervisor and the JPL Industrial Hygiene Office x4-9893.

- When ordering any AlBeMet or Beryllium-containing stock, part or component, it must be specified to have Beryllium containing identification and/or be ink stamped with the hazard warning above.
- Any AlBeMet or Beryllium-containing stock, part or component sent off-Lab shall be labeled or identified as a Beryllium containing part with a hazard warning.

QC67 ORGANIZATION'S RESPONSIBILITY FOR SUPPLYING ELECTROSTATIC DISCHARGE (ESD) PACKAGING AND PERSONAL PROTECTIVE CLEAN ROOM DEVICES:

"Organization shall be responsible for assuring the ESD packaging (bags, sleeves, foam, boxes, etc.) or personal protective devices for clean room use (smocks, beard covers, hoods, face masks, gloves, wipers, etc.) procured per this Contract/Purchase Order meet the following applicable specification requirements:

- The Specification for testing most materials is MIL-STD-1246C Product Cleanliness Levels and Contamination Control Program.
- The Particulate tests are performed in accordance with MIL-STD-1246C, Notice 1, Table I and should meet a level between 100 and 500 depending on the Classification of clean room the material will be used in. These would normally be materials you could not flow air through, such as clean room notebooks, clean room paper products for printers etc.
- The Non-Volatile Residue tests are performed per MIL-STD-1246C, Notice 2, Table II and should meet a level "A" requirement.
- Clean room garments and wipes, for particulates, use a different method, which is ASTM F51-68. Sizing and Counting Particulate Contaminants in and on Clean Room Garments. The garments, such as beard covers, smocks, hoods face masks and wipers have to meet a cleanliness level per this specification of Table X2.1 Class "A".
- Bag materials may also use this method with a slight deviation in the procedure. The bags are creased in several directions and vacuumed using a Sandia probe and loose materials are collected on a Millipore filter and then counted.

Evidence or certification of these requirements must be provided in one reproducible printed form. If the Organization is unclear as to the requirements to be met, Contact the JPL Procurement Quality Assurance office at 818-393-7592 for the current applicable administrator of the requirements."

Guidance:

- Applies to all lab procurements of the supplies listed.

  Current contacts:

  1. The particulate tests are performed by William Neiderheiser, Bldg. 197, Room 121, (818) 354-3465.
  2. The Non-Volatile residue tests are performed by Mark Anderson, Bldg. 83, Room102A, (818) 354-3278.

The ESD tests are performed by Roger Welker, Bldg. 83, (818) 354-9415.

QC68 WORKMANSHIP SPECIFICATION

"All soldering and assembly on items supplied for this purchase order or contract shall be in compliance with the class of use indicated on the purchase order or contract and as defined below. Unless specified, the requirements of this clause are not imposed on the procurement of Commercial-Off-The-Shelf (COTS) or catalog type assemblies and subassemblies. Use by the organization of a higher class of soldering standard than required is acceptable, except where it increases the purchase price. The suppliers may use their own workmanship standard in place of the imposed requirement, if the standard is submitted to and approved by JPL as equal to or higher than the imposed requirement.

1. Commercial products where the major requirements are functions of the completed assembly: All soldering and assembly shall be in compliance with IPC/EIA J-STD-001, Revision C, Class 1 requirements.
2. Commercial products where continued performance and extended life is required, and for which uninterrupted service is desired, but not critical. (Typically, the end use environment will not cause failures.): All soldering and assembly shall be in compliance with IPC/EIA J-STD-001, Revision C, Class 2 requirements."
3. Commercial products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems: All soldering and assembly shall be in compliance with IPC/EIA J-STD-001, Revision C, Class 3 requirements.
4. Products where NASA soldering standards are specified: All soldering and assembly shall be in compliance with NASA-STD-8739.3 w/change 2.
5. Products used on JPL flight hardware or critical Ground Support Equipment (GSE) or Deep Space Network (DSN) systems: All soldering and assembly shall be in compliance with HPL D-8208 Rev. I, DocID 35120.

This specification supercedes any other requirement on the part drawing or specification.

Incorporate by reference QC04, that items supplied for this purchase order or contract have passed inspection by the organization's Quality Assurance function for applicable class of IPC/EIA J-STD-001 Revision C or the indicated NASA or JPL specification."

Guidance:

- This clause shall be used for the purchase of flight hardware and critical Ground Support Equipment (GSE) and non-flight equipment.
- All classes of the IPC/EIA J-STD-001, Revision C specification are Commercial. They do not meet environmental specifications for products going into space, or critical to mission support.
- Call out the clause and the class of workmanship (e.g. "QC68 for Class 3" for non-flight equipment, "QC68 for NASA" for the NASA standard, and QC68 JPL D8208" for the JPL standard).
- All JPL flight and critical GSE shall meet "QC68 JPL D-8208" soldering standard.
- QC04 Certification to Customer's Specification Requirements shall be invoked with this clause.

QC69-N PACKAGING, HANDLING & LABELING [NASA AQC21]

"The Organization shall provide packaging that maintains the quality of the fabricated item and prevents damage, deterioration, substitution or loss in transit. The organization shall label the exterior of the package to ensure adequate identification of the precautions needed to ensure the integrity of the product being shipped. The organization must specify the handling and shipping methods that ensure proper and on-time delivery without damage to the product. The organization shall ensure that special labeling requirements shall also be listed in the appropriate shipping documents and on each package"

Guidance:

- Packages shall be marked to identify specific handling and environmental protection requirements. All products that are ESD sensitive shall be properly labeled per MIL-STD-129.
- Preservation techniques for products that require environmental protection shall be noted on the exterior of each package (e.g., temperature, stacking or lifting limitations; inert environments). Products that have specific cleanliness requirements shall be identified to ensure that product packaging is only opened in an appropriate, clean environment.

QC70 Printed Wiring Boards (PWB)

The Organization shall design and/or fabricate all printed wiring boards (PWBs) per the requirements of Section 3.6 of JPL D-8208, *Spacecraft Design and Fabrication Requirements for Electronic Packaging and Cabling*. In particular, for space flight applications and critical ground support equipment, the supplier is responsible for the deliverable data package. See D-8208, Section 3.6, Para. 6.2.

The current version of D-8208 is in the JPL RULES under Information System. The specifications in Section 3.6 are applicable to all NASA Jet Propulsion Laboratory programs and contracts using PWBs for space flight applications and critical ground support equipment.

For Deep Space Network (DSN) requirements, reference IPC-2221, General Standard on Printed Boards. Reference JPL D-14183 design requirements for DSN equipment.

Guidance

- Required for all manufacture of all space flight applications and critical ground support equipment PWBs
- To be invoked on all procurements for flight and critical ground support equipment PWBs

QC71 Flexible and Rigid-Flexible Printed Wiring Boards (PWB)

The Organization shall design and/or fabricate all printed wiring boards (PWBs) per the requirements of Section 3.7 of JPL D-8208, *Spacecraft Design and Fabrication Requirements for Electronic Packaging and Cabling*. In particular, for space flight applications and critical ground support equipment, the supplier is responsible for the deliverable data package. See D-8208, Section 3.7, Para. 6.2.

The current version of D-8208 is in the JPL RULES under Information System. The specifications in Section 3.7 are applicable to all NASA Jet Propulsion Laboratory programs and contracts using PWBs for space flight applications and critical ground support equipment.

For Deep Space Network (DSN) requirements, reference IPC-2221, General Standard on Printed Boards. Reference JPL D-14183 design requirements for DSN equipment.

Guidance

- Required for all manufacture of all space flight applications and critical ground support equipment PWBs
- To be invoked on all procurements for flight and critical ground support equipment PWBs

QC72 QUALITY MANAGEMENT SYSTEM PER AS9100

The Organization shall have a quality program that complies with the Engineering Society for Advancing Mobility Land Sea Air and Space International (SAE) Aerospace Standard (AS), AS9100 "Quality Management Systems - Aerospace Specific Requirements" (Model for Quality Assurance in Design/Development, Production, Installation and Servicing).

If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its sub tiers.

The Organization shall present objective evidence of AS9100 compliance by providing JPL's Procurement Quality Assurance Group with one or more of the following:

1. Copy of AS9100 3rd Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful AS9100 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA's Joint Audit Planning Committee (JAPC).
3. Self-declaration of AS9100 compliance with a completed gap analysis, subject to JPL acceptance (see AS9101A for gap analysis tool).

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

Guidance: This clause is used for complex items or items requiring JPL-directed supplier design activities, if those items are also used for flight, could eventually be used for flight, or are identified as JPL Critical Items (JCI).
AS9100 requirements are generic and are intended to be applicable to all organizations that provide products and or services to the Aerospace Industry, regardless of type and size. Where any requirement(s) of the AS9100 standard cannot be applied due to the nature of the organization and its products/services, this can be considered for exclusion only if the requirement(s) are within clause 7 and such exclusions do not affect the Organization's ability, or responsibility, to provide product that meets customer and applicable regulatory requirements.

QC 73 QUALITY MANAGEMENT SYSTEM PER AS9003

The Organization shall have, as a minimum, an inspection and test system that complies with The Engineering Society for Advancing Mobility Land Sea Air and Space International (SAE) Aerospace Standard (AS) AS9003 "Inspection and Test Quality System".
If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its sub tiers.
The Organization shall present objective evidence of AS9003 compliance by providing JPL's Procurement Quality Assurance Group with one or more of the following, as a minimum:

1. Copy of AS9003 3rd Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful AS9003 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA's Joint Audit Planning Committee (JAPC).
3. Self-declaration of AS9003 compliance with a completed gap analysis, subject to JPL acceptance.

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

Guidance:
This clause is used for manufacturers/fabricators/processors and testing laboratories when end items will be used for flight, could ultimately be used for flight or are identified as JPL Critical Items (JCI). If it's been determined that the supplier meets "less than" the full requirements of ISO 9001:2000 or AS9100, or if it's known at the time of purchase that the supplier will not perform any JPL-delegated design activities, and parts are of a non-complex nature, this clause will apply. Examples are machined parts and assemblies made to JPL drawings (e.g. 1020xxxx), JPL standard parts (e.g. STxxxxx), military standard parts (e.g. AN, MS, NAS, NS, etc.), raw material, and electronic components procured from original manufacturer.

The intent of AS9003 (which is a model based on final inspection and test) is for small, non-design responsible, make-to-print shops. AS9003 has less stringent requirements compared to AS9100 due to the scaled back nature of operations of such organizations.

NOTE:

Those Organizations compliant/certified to ISO 9001:2000 or AS9100 already meet the requirements of AS9003, since AS9003 is based on ISO 9001:1994 & Mil-I-45208 and adds specific requirements for the outsourced inspection and test quality system providers.

QC74 QUALITY MANAGEMENT SYSTEM FOR DISTRIBUTORS PER AS9120

The Organization shall have a quality control system that complies with The Engineering Society for Advancing Mobility Land Sea Air and Space International (SAE) Aerospace Standard (AS) AS9120 “Quality Management Systems - Aerospace Requirements for Stockist Distributors” or the International Organization for Standardization (ISO) standard ISO 9001:2000 “Quality Management Systems - General Requirements”, as a minimum.

If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its subtiers.

The Organization shall present objective evidence of AS9120 or ISO 9001:2000 compliance by providing JPL’s Procurement Quality Assurance Group with one or more of the following:

1. Copy of AS9120 or ISO 9001:2000 3rd Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful AS9120 or ISO 9001:2000 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA’s Joint Audit Planning Committee (JAPC).
3. Self-declaration of AS9120 or ISO 9001:2000 compliance with a completed gap analysis, subject to JPL acceptance.

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

Guidance:

This clause is used for distributors of flight items, items that may be used for flight and JPL Critical Items (JCI). Examples of items often procured from distributors are: military standard parts (e.g. AN, MS, NAS, NS, etc.); commercial catalog items (electronic components are often catalog part numbers); and raw material. Use this clause in addition to certification clauses (e.g. QC02-N, QC06-N), normally applied for specific end item. Original manufacturer information will be included in certification. Note: JPL Standard Parts (STxxxxx) may only be procured directly from manufacturers approved

or certified to AS9003 (QC73), not from distributors, unless distributor is approved to alter hardware (value-added work).

AS9120 is based on ISO 9001:2000 and adds specific requirements, per AS9100, that are relevant for stockist or pass-through distributors for the aerospace industry. It applies for organizations that procure parts/materials/assemblies to resell, distribute, and/or warehouse for customers in the aerospace industry (this includes organizations that procure products and split them into smaller quantities). It is not intended for organizations that rework or repair products. Organizations that perform work that affect or could affect product characteristics or conformity shall use AS9100 or another applicable quality management system standard.

All ISO 9001:2000 requirements are generic and are intended to be applicable to all organizations, regardless of type, size and product provided. Where any requirement(s) of the ISO 9001:2000 standard cannot be applied due to the nature of the organization and its products/services, this can be considered for exclusion only if the requirement(s) are within clause 7 and such exclusions do not affect the subcontractor's ability, or responsibility, to provide product that meets customer and applicable regulatory requirements.

NOTE:
Those Organizations compliant/certified to ISO 9001:2000 or AS9100 already meet the requirements of AS9120, since AS9120 is based on ISO 9001:2000 & AS9100.

QC75 FOD Prevention Program

Organizations providing goods and services to the Customer shall participate in an effective Foreign Object Debris and Damage (FOD) Prevention program. Customer auditors who normally visit organization's facility may include surveillance for objective evidence of this participation.

The Organization's Foreign Object Damage (FOD) program shall meet the requirements of MIL-STD-980, Foreign Object Damage (FOD) Prevention in Aerospace Production. Assembly operations sheets and maintenance worksheets shall contain FOD check call out with signature/stamp evidence of compliance.

See the following website for FOD prevention guidelines:

http://www.nafpi.com/nafpiguideline.pdf

Guidance:

This clause will be used for purchases of all Major Subcontractor flight equipment and services. This clause should also be used for suppliers who assemble or fabricate any product where contamination could cause a nonconformance. The clause would be most appropriate where assembly operations conducted by the organization would cover up possible contamination or make subsequent inspections inaccessible to detection of the contamination.

QC76 NADCAP Accreditation of Special Process Sources

Organizations performing special processes, as delineated below, shall obtain National Aerospace and Defense Contractors Accreditation Program (NADCAP) accreditation prior to next Customer process audit. Organization shall present certification of this aforementioned accreditation to Customer auditor upon request.

Special processes requiring NADCAP accreditation:

- Heat Treatment
- Non-Destructive Testing
- Chemical Processes (e.g. Chemical Milling)
- Welding
- Brazing
- Shot peening (part of the Non-conventional Machining and Surface Enhancement)
- Material Testing by independent test laboratories

Guidance:

This clause will be used for all purchases of flight items requiring special processes, in addition to the quality clause normally imposed for the specific process, e.g.QC14-N for NDT.

QC77 Electrostatic Discharge (ESD) Protection Program and Packaging (JPL D-1348)

"The organization shall document and implement an ESD Control Program in accordance with JPL D-1348 Rev. F Electrostatic Discharge Control Standard for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices). Parts must be properly handled, packaged and identified as required. All goods will be placed in conductive or static-dissipative packages, tubes, carriers, conductive bags, etc., for shipment. The packaging must be clearly labeled to indicate that it is an ESD sensitive part and shall be treated as ESD sensitive. Electrical parts that may be used or shipped in conjunction with ESD sensitive parts shall be treated as ESD sensitive."

Guidance:

- If you are receiving ESD sensitive parts that are being used in a critical application, then the organization providing the parts should have an ESD protection program in compliance with JPL D-1348 Rev. F
- Parts sensitive to voltages less than 20 volts (e.g., unprotected gate oxide devices) require additional controls beyond those specified in JPL D-1348 Rev. F
- When the part is being procured to an existing technical specification, it should be reviewed prior to applying this clause to ascertain the ESD control requirements imposed by the standard to determine if this clause is necessary.
- When the ESD sensitivity of a part or assembly is not known or not identified (e.g., inputs/outputs at black box level), the item shall be treated as ESD sensitive.

Note: This clause is applicable for procurement of ESD sensitive electrical piece parts excluding electrically initiated explosive devices.

QC78 QUALITY MANAGEMENT SYSTEM PER ISO 9001:2000

The Organization shall have a quality program that complies with the International Organization for Standardization (ISO) standard, ISO 9001:2000 "Quality Management Systems - General Requirements", as a minimum.
If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its sub tiers.
The Organization shall present objective evidence of ISO 9001:2000 compliance by providing JPL's Procurement Quality Assurance Group with one or more of the following, as a minimum:

1. Copy of ISO 9001:2000 3rd Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful ISO 9001:2000 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA's Joint Audit Planning Committee (JAPC).
3. Self-declaration of ISO 9001:2000 compliance with a completed gap analysis, subject to JPL acceptance.

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

Guidance:
This clause is normally be used for complex items or items involving JPL-directed design activities, when those items are used for flight, could potentially be used for flight, or are identified as JPL Critical Items (JCI).
The third edition of ISO 9001 cancels and replaces the second edition (ISO 9001:1994) together with ISO 9002:1994 and ISO 9003:1994. It constitutes a technical revision of these documents. Those organizations which have used ISO 9002:1994 and ISO 9003:1994 in the past may use this International Standard by excluding certain requirements in accordance with ISO 9001:2000 paragraph 1.2.

All ISO 9001:2000 requirements are generic and are intended to be applicable to all organizations, regardless of type, size and product provided. Where any requirement(s) of the ISO9001:2000 standard cannot be applied due to the nature of the organization and its products/services, this can be considered for exclusion only if the requirement(s) are within clause 7 and such exclusions do not affect the subcontractor's ability, or responsibility, to provide product that meets customer and applicable regulatory requirements.

Those Organizations compliant/certified to AS9100 already meet the requirements of ISO 9001:2000, since AS99100 is based on ISO 9001:2000 and adds specific aerospace requirements.

QC79 Quality Management System for Distributors or Manufacturers (COTS)

If the Organization is a <u>distributor</u> of the item, the following applies:

The Organization shall have a quality control system that complies with The Engineering Society for Advancing Mobility Land Sea Air and Space International (SAE) Aerospace Standard (AS) AS9120 “Quality Management Systems - Aerospace Requirements for Stockist Distributors” or the International Organization for Standardization (ISO) standard ISO 9001:2000 “Quality Management Systems - General Requirements”, as a minimum.
If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its subtiers.
The Organization shall present objective evidence of AS9120 or ISO 9001:2000 compliance by providing JPL’s Procurement Quality Assurance Group with one or more of the following:

1. Copy of AS9120 or ISO 9001:2000 3rd Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful AS9120 or ISO 9001:2000 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA’s Joint Audit Planning Committee (JAPC).
3. Self-declaration of AS9120 or ISO 9001:2000 compliance with a completed gap analysis, subject to JPL acceptance.

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

If the Organization is the <u>manufacturer</u> of the item, the following applies:

The Organization shall have, as a minimum, an inspection and test system that complies with The Engineering Society for Advancing Mobility Land Sea Air and Space International (SAE) Aerospace Standard (AS) AS9003 "Inspection and Test Quality System", or the International Organization for Standardization (ISO) standard ISO 9001:2000 “Quality Management Systems - General Requirements”, as a minimum.
If the Organization subcontracts any of the JPL procurement to other suppliers, the Organization shall flow down this same requirement to its sub tiers.
The Organization shall present objective evidence of AS9003 or ISO 9001:2000 compliance by providing JPL’s Procurement Quality Assurance Group with one or more of the following, as a minimum:

1. Copy of AS9003 3rd or ISO 9001:2000 Party Registration/Certification, subject to JPL acceptance.
2. Copy of successful AS9003 or ISO 9001:2000 2nd Party Audit, subject to JPL acceptance. Note: The 2nd Party Audit shall be from other NASA Centers, Primes, and/or Partners of NASA’s Joint Audit Planning Committee (JAPC).

3. Self-declaration of AS9003 or ISO 9001:2000 compliance with a completed gap analysis, subject to JPL acceptance.

The Organization shall submit the required data to the Jet Propulsion Laboratory, attention PQA Quality Audit Coordinator, 4800 Oak Grove Drive (MS 241-122), Pasadena, CA 91109-8099, or provide an electronic version via e-mail to PQA@jpl.nasa.gov.

Guidance:
This clause is used only for Non-complex, Commercial-Off-The-Shelf (COTS) items that can be procured from either a distributor or from the original manufacturer and the supplier is not known at the time that the purchase request is issued. It will not be used for items that must be procured from a manufacturer, such as JPL-designed items, which would not be available from distributors, and require QC72, QC73 or QC78. Note: For distributable items when supplier is already known, use QC74 for a distributor or QC73 for the manufacturer of the item.
AS9120 is based on ISO 9001:2000 and adds specific requirements, per AS9100, that are relevant for stockist or pass-through distributors for the aerospace industry. It applies for organizations that procure parts/materials/assemblies to resell, distribute, and/or warehouse for customers in the aerospace industry (this includes organizations that procure products and split them into smaller quantities). It is not intended for organizations that rework or repair products. Organizations that perform work that affect or could affect product characteristics or conformity shall use AS9100 or another applicable quality management system standard.

All ISO 9001:2000 requirements are generic and are intended to be applicable to all organizations, regardless of type, size and product provided. Where any requirement(s) of the ISO 9001:2000 standard cannot be applied due to the nature of the organization and its products/services, this can be considered for exclusion only if the requirement(s) are within clause 7 and such exclusions do not affect the subcontractor's ability, or responsibility, to provide product that meets customer and applicable regulatory requirements.
NOTE:
Those Organizations compliant/certified to ISO 9001:2000 or AS9100 already meet the requirements of AS9120, since AS9120 is based on ISO 9001:2000 & AS9100.
Those Organizations compliant/certified to ISO 9001:2000 or AS9100 already meet the requirements of AS9003, since AS9003 is based on ISO 9001:1994 & Mil-I-45208 and adds specific requirements for the outsourced inspection and test quality system providers. The intent of AS9003 (which is a model based on final inspection and test) is for small, non-design responsible, make-to-print shops only. AS9003 has less stringent requirements compared to AS9100 due to the scaled back nature of operations of such organizations.

QC80-S USE OF COMMERCIAL OR COTS SOFTWARE AS PART OF CLASS A OR CLASS B SOFTWARE.

”Commercial, or Commercial-Off-The-Shelf (COTS) software that is used in conjunction with Class A or Class B software shall be supplied by an Organization on JPL’s Approved Organization List (ASL). The list will also identify the software name and version number of the software approved for use. The Organization’s responsibility for acceptable software operation is not diminished by the Organization’s use of JPL’s ASL.”

Guidance:

- Certain processes performed on board a spacecraft or to support the build of flight software must be error free or have a very low error rate. This type of software can be very expensive and require specialists to produce. If commercial software exists that can be used for these applications, it can result in significant savings.
- This commercial software must be uniquely identified by name and version when purchased. Not all of the software produced by a vendor is approved. For example: Microsoft is on the list, but MS Windows Operating Systems of any version should **NOT** be used because General Protection Faults cause the system to freeze up. Wind River’s VxWorks and other operating systems have been used on numerous spacecraft because they specifically do not freeze up.
- Other examples of low error rate software exist in the field of compilers, assemblers, linkers, simulators and test software.
- Use of this clause must be coordinated between the JPL and vendor prior to license or purchase of COTS software. The following questions must be resolved:

  timely notification of anomalies already found in the code by users,

  how the correction of errors found by JPL in the code will be made,

  the long term maintenance of the code after new revisions are released, (i.e., how long will the present version be supported?) and

  the availability of source code to JPL for archival purposes,

Definitions:

Mission-Critical (Class A): Flight or ground software that is necessary either to ensure

mission success, or if it does not function as specified, that could cause loss of spacecraft, seriously degrade the attainment of primary mission objectives, or cause injury to humans or mission-critical hardware. Examples of serious degradation of mission objectives include loss of a mission-critical event, loss of science return from multiple instruments, or loss of a large fraction of the engineering telemetry data.

Mission Support (Class B): Flight or ground software that is necessary for the science return from a single (non-critical) instrument, or supports the timely generation of mission sequences, or is used to process or analyze mission data, or other software for which a defect could adversely impact attainment of some secondary mission objectives or cause operational problems for which potential workarounds exist. Examples of Class B software include software that supports pre-launch integration and test, mission data processing and analysis, analysis software used in trend analysis and calibration of flight engineering parameters, or software employed by the Network Operations and Control Center (which is redundant with systems used at the tracking complexes). Class B software must be developed carefully, but validation and verification effort is generally less intensive than for Class A.

QC81-S TECHNICAL AND PROJECT REVIEWS

"Each program is evaluated at certain points in its implementation. The purpose of these reviews is to establish the program's status, if it has completed its current phase, and to determine if it is ready to continue into the next phase. As a minimum the Organization shall support performing the following Technical and Project Reviews with the Customer by providing essential documentation:

- System Requirement Review (SRR) The System Requirements Review evaluates the completeness, consistency, and achievability of system, subsystem, assembly and program set requirements necessary to fulfill the mission need statement.
- Preliminary Design Review (PDR) The Preliminary Design Review evaluates the readiness of the project, system, subsystem, or assembly or program set to proceed with detail design.
- Critical Design Review (CDR) The Critical Design Review evaluates the readiness of the project, system, subsystem, or assembly or program set to proceed with development, including coding, assembly of code, integration, and test.
- Test Readiness Review (TRR) The Test Readiness Review evaluates the readiness of the product or process to be tested for the Customer, plus the readiness of test procedures, test equipment, and test facilities for use.
- System Delivery Review (SDR) The System Delivery Review evaluates the readiness of the product or process for delivery to a Customer or to a Launch site, usually associated with transition to a subsequent phase.

It is recommended that the Organization precede these reviews with its own internal reviews of project status, and the material to be presented."

Guidance:

- The purpose of these reviews is to establish the status of the program at certain fixed points in the life of the contract. Operation of these reviews is given in "JPL Guidelines for Reviews D-10401".
- This establishes there are five transition points in the contract where the Customer will review the Organization's performance.

QC82-S SOFTWARE CONFIGURATION MANAGEMENT SYSTEM (LESS THAN ISO 10007).

"Organization shall be responsible for uniquely identifying, maintaining, and controlling copies of each version of every software unit, component, assembly, every computer file, and every software document produced by this contract. This includes deliverable, supporting, test, and simulation software, computer files containing more than one piece of software, and documents involving plans, procedures, requirements, interfaces, design documents, test plans, test cases run and test case results, Software Qualification Procedure/s, copies of Software Qualification Test (SQT) results provided by Quality Assurance and SQT test reports.

The Organization shall be responsible for controlling and tracking non-conformance reports against software, processes, and software documents. This includes tracking the status of all non-conformances from discovery until verification that corrections have been properly made. The Organization shall be responsible for verifying only authorized changes are made to the software, processes and software documents.

With each shipment of software the Organization shall submit “configuration documents”, which define the requirements, design, build/production and verification for that contractual item. These documents shall be signed and dated by an official of the Organization’s Quality Assurance department, and shall include the aforementioned documentation and the following minimum information*:

- Organization’s Contract/Purchase Order number including any change orders
- Line item number
- Copy of all object code, source code, and associated non-COTS files necessary to produce the object code.
- List of all documents, and their revision level, associated with this shipment. Including procedures, requirements, interfaces, design documents, test plans and procedures, copies of test results provided by Quality Assurance and test reports.
- The procedure for converting source code into object code.
- List of all open problem reports and all problem reports closed since the last shipment. The list shall identify the revision(s) of hardware, software, and documents caused by a change to close a problem report.
- Copy of all problem reports on the list above with the associated Software Change Control Board activities.
- Customer approved deviations and waivers (as applicable).
- List of all object code, source code and associated files necessary to produce

the object code, including each piece of software's unique name, current version, date and time of this version's creation, and size.

* The first eight items are usually combined into a document called the Release Description Document (RDD)"

Guidance:

- Configuration Management (CM) is not required by this clause, but the tasks are such that it is apparent that it is a full time librarian and control job.
- CM control of software corrective action is very important because there is no environmental test/manufacturing test phase where further errors might be found. Software is only as good as the test cases that are run on it. If the set of test cases does not test everything the software can do, the quality of the software could be compromised.
- Careful tracking of the problems is essential, because when the software passes Software Qualification Test (SQT) it is fielded. Therefore, after SQT the cost of finding and fixing any errors increases dramatically.
- From the error rate the Software CogE can evaluate the error density of the software and documentation, and the maturity of various portions of the software.

Non-conformance: A condition of any product, material or service in which any characteristic does not conform to requirements specified in the contract, drawings, specifications, or other approved product description. Includes failures, discrepancies, defects, anomalies, and malfunctions.

QC83-S SYSTEM REQUIREMENTS REVIEW (SRR) DOCUMENTATION

"The Organization shall support the System Requirements Review (SRR) by providing the Customer with approved copies of the Organization's Software Management Plan (SMP), the Software Requirements Document (SRD), and the Software Interface Specification (SIS). The Organization's Software Quality Assurance (SQA) function shall approve these documents before being submitted to the Customer. The Customer shall receive them at least 60 days before the SRR.

The SMP shall detail the processes the Organization uses to conform to ISO 9000:2000 or AS9100A in the development of software. The SMP shall include information on the Organization's structure, the schedule and milestones, reporting progress metrics, risk management, sub-contractor management, proposed developmental environment, provision for JPL/NASA reviews, Software Configuration Management activities, a closed corrective action system, software engineering activities, assignment of and testing for reserve capacity, maintenance after delivery, etc.

The SRD shall identify all the inputs into the software, and the required functional operations and changes necessary to produce all the outputs. The required inputs, required functional operations and changes, and the required outputs shall be described in such a way that they can be individually produced, identified and tested. This description will include the internal interfaces between functions. The SRD may either include the Software Interface Specification (SIS) or reference it. The method of test (i.e., Inspection, Analysis, Demonstration, and Test) for each requirement shall be indicated.

The SIS shall identify and describe, in sufficient detail to permit programming, all the external interface signals into and out of the software being designed. It shall include for each signal a unique identifier, source and destination, units of measure, limit/range of values, accuracy required and precision/resolution required. If this information is already included in another document, the other document shall be provided."

Guidance

- Requiring the SMP, SRD and SIS to be approved and available at SRR compels the Organization's system engineering, software engineering, hardware engineering, and Software Quality Assurance groups to be involved in the system development planning.
- By requiring SMP to provide information on maintenance after delivery, it compels planning to handle anomalies after delivery. (This is also an ISO requirement).

- Requiring the SRD and SIS to be available at SRR it compels early establishment of basic requirements, and reduces the risk that there will be large changes later that disrupt what has been developed.
- Requiring the SRD to identify how each requirement is tested may cause involvement of the Software Test group.

QC84-S SOFTWARE DEVELOPMENT ENVIRONMENTAL CHANGES

"The Organization shall notify the Customer of proposed changes in the software tools, firmware devices, hardware, and processes necessary to perform the software developmental effort, and shall obtain approval from the Customer prior to implementing the change. This includes changes to compilers, assemblers, linkers, loaders, operating system, debuggers, test harnesses/test benches, emulators, simulators, test tools, processors, PROMs, etc. All changes ranging from purchase of products from a different vendor to revisions to the existing products shall be documented, implemented under controlled procedures, and reported to the Customer."

Guidance:

- Numerous processes, hardware and support software are used to support the building and testing of flight software, and can affect it. Changes to the hardware, processes or support software may introduce errors into the software and are similar to changes made to hardware critical processes.
- QC18-N Flowdown Requirements should be imposed to flow this clause down to the Organization's subcontractors.
- Requirement of a Software Management Plan (SMP) per QC83-S System Requirements Review (SRR) Documentation should be used to make the Organization define the software development environment, and any changes to it should be reported in response to the clause above.

Definition:

Software Development Environment: The set of automated tools, firmware devices, and hardware necessary to perform the software development effort. The automated tools may include, but are not limited to compilers, assemblers, linkers, loaders, operating system, debuggers, simulators, emulators, test tools, documentation tools, and data base management system(s).

QC85-S SOFTWARE NON-CONFORMANCE REPORTING:

"**Definitions:**

Non-conformance: A condition of any product, material or service in which any characteristic does not conform to requirements specified in the contract, drawings, specifications, or other approved product description. This includes failures, discrepancies, defects, anomalies, and malfunctions.

Software Unit: The smallest stand alone piece of code.

Software Component: A group of software units or software units and software components working together.

Assembly: A group of Hardware and Software units and components working together.

The Organization shall ensure that a product that does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. The controls and related responsibilities for dealing with non-conforming product shall be defined in a documented procedure.

The Organization's documented procedure shall define the responsibility for review and authority for the disposition of a non-conforming product and the process for approving personnel making these decisions.

Data Requirements: Any non-conformance discovered by anyone in the Organization or by the Customer, on products in their control, shall be documented by the Organizations' approved method of non-conformance reporting. If affecting form, fit, or function, each non-conformance shall be reported on a separate report. This report shall include a detailed description of the non-conformance; location (by naming the software unit or units involved, and/or by documents involved) and exact callout of the violation specification requirement (including sub-paragraph and/or illustration number). It shall also list what type of test revealed the discrepant condition, and what, if any, subsequent actions were taken prior to disclosure.

Non-conformance Preliminary Review: The preliminary review process shall be initiated with the identification and documentation of a non-conformance. A preliminary review shall be the initial step performed by the Organization to determine if the non-conformance is actually software. The documentation shall be reviewed by Organization's SQA for completeness, and then submitted to the Organization's corrective action procedure.

Note: Preliminary review does not negate the requirement to identify, segregate, document, report, and disposition non-conformance.

After unit test of software, all non-conformances shall be reported to the Customer within 3 working days after the non-conformance is discovered."

Guidance:

- Requirements for providing data on non-conformance should be specified as a data item deliverable. Where possible, use of a Organization's internal tracking and reporting system should be considered. It should be considered unsuitable if it restricts the persons able to report non-conformance.
- The Organization must have, or create a procedure for reporting non-conformances. This clause is intended to address non-conformance software reporting, which includes all document changes.
- This clause should be used for all contracts involving software.
- Invoke QC86 Corrective Action with this clause. What is the purpose of reporting non-conformance unless it is corrected?

QC86 CORRECTIVE ACTION:

"Organization shall have a documented corrective action process in place as part of their quality program. As part of this process, all non-conformances identified with hardware, software or documentation, by either any Organization or JPL personnel shall be reported. All non-conformances shall be tracked until resolution. Root causes shall be determined and preventative measures shall be implemented to prevent reoccurrence. Follow-up test and monitoring shall be performed as validation.

All non-conformances relating to hardware, software, documentation, test equipment or facility problems that could impact JPL deliverables, shall be *classified* as below, and shall be reported to JPL Quality Assurance within three days of occurrence.

For hardware, unless MRB authority has been delegated per **QC41**, Non-conformances that require the convening of a MRB shall be submitted to JPL per the requirements of **QC39**. The Organization will be advised of the specific action to take in reference to the MRB request. An MRB record, once disposition has been made shall be kept by the Organization as quality records and made available to the Customer upon request.

For software, a Software Change Control Board (SCCB) shall be convened, which shall include the JPL Cognizant Engineer as a member. The SCCB shall authorize the investigation of the causes of the non-conformance, the determination of the changes required to correct the discrepancy, and having this information authorize the corrective actions for both Class 1 and Class 2 changes. A record of the SCCB actions shall be kept by the Organization as quality records and made available to the Customer upon request.

For non-conformance where both hardware and software are involved, the MRB shall have precedence.

Class I changes: those that affect form, fit or function; affecting reliability, workmanship, performance, safety, interfaces or other approved JPL documentation shall be submitted for MRB or SCCB disposition.

Class II changes: those that do not affect form, fit or function, and do not require submittal for MRB, shall be documented and shall be submitted to JPL upon request.

Copies of all non-conformance documentation shall be submitted as part of the procurement End Item Data Package.

Submittal of a MRB request or SCCB authorization does not guarantee, or obligate JPL to accept (concur with) the Organization's disposition, or to disposition non-conforming procured items for ultimate acceptance attempt, if JPL provides a rationale why concurrence is not granted."

Guidance:

- The Organization must have, or create a procedure for handling all non-conformances.
- For Hardware this clause is applied in conjunction to QC39 Non-conformance Reporting, and QC41 Material Review Board (MRB) Authority - Granted.
- For Software this clause is applied in conjunction with QC85-S Software Non-conformance Reporting. Because of software's complexity, an Organization's Software Change Control Board will always exist, with the JPL CogE as a member.
- For very small companies the SCCB may consist of the owner/SQA, programmer/CM librarian, tester, and JPL CogE.
- Records of actions to handle non-conformance should be specified as a data item deliverable. Where possible, use an Organization's corrective action process.

QC87-S SOFTWARE TESTING

"The Organization shall develop tests for and test each level of software assembly beginning with unit testing, component testing, assembly testing and Software Qualification Test of the Contract Item. All hardware and software in these tests, and the test results, shall be under the control of Configuration Management. Automatic test tools and a Software Configuration Management System from a Organization on JPL's Approved Organization List (ASL) shall be used. The individuals writing the tests shall not be involved in writing the code being developed, however the developers may aid the testers in an advisory capacity.

Definitions:

Software Unit is the smallest stand alone piece of code.

Software Component is a group of software units, or software units and software components working together.

Assembly is a group of hardware and/or software units and components working together."

Guidance

- Flight software should be tested to the same degree as flight electronics with each level of assembly being tested.
- The tests are retained and modified as anomalies are found, so the tests do not have to be re-created for each problem.
- Invoke QC85 Software Non-conformance Reporting and QC86 Corrective Action Process with this clause. If any software non-conformance is found, it should be reported and corrected.

QC88-S FLIGHT SOFTWARE MARGINS

"Prior to hardware design or procurement the system (the computer, memory, and communication system) shall be analyzed to establish the value of critical parameters needed for proper performance of the software. These parameters are: CPU speeds, control cycle rates, interrupt rates and durations, communications bandwidth/throughput, random access memory (RAM), and Erasable programmable read-only memory (PROM and EPROM).

At hardware selection time each critical parameter of the hardware shall have a minimum capability of 400% of the Current Best Estimate.

At PDR each critical parameter shall have a minimum capability of 200% the Current Best Estimate.

At launch each parameter shall have a minimum capability of 15% of the Current measured value.

The Organization shall provide a rational and recovery/options for significant deviations from the margin requirements."

Guidance:

- Software can be modified after launch. Usually the size gets larger; therefore a margin is still needed.
- Changing the computer, memory or communication system after PDR has a major impact on cost and delivery schedule.
- These values are based on JPL experience.

QC89-S PRELIMINARY DESIGN REVIEW (PDR) DOCUMENTATION

"The Organization shall support the Preliminary Design Review (PDR) by providing the Customer with approved copies of the Organization's Software Design Document showing the Top Level Design of the proposed software and draft details of the internal interfaces, and the Software Test Plan (STP). The Organization's Software Quality Assurance (SQA) function shall approve these documents before being submitted to JPL. JPL shall receive them at least 60 days before the PDR.

The STP shall describe the type of tests (i.e., nominal/extreme/out of range values, timing, etc.) required to verify the operation of the software. The description shall include a description of the hardware and software environment in which the various levels of test(s) shall be performed, the estimated duration of the tests, and the assets in the form of software, hardware, and personnel and manpower required to be available to perform the tests. A planned schedule shall be provided showing the time-phased use of test assets, to show they are sufficient to handle development, testing and corrective action of the software during development.

Open action items from the SRR shall be resolved, or plans for resolving them will be submitted. A current estimate of Flight Software Margins shall be submitted per QC88-S.

Additionally, the Organization shall submit any previously approved and submitted documents having changes, with the Organization's SQA approval indicated on them. JPL shall receive these re-submitted documents at least 30 days before PDR."

Guidance:

- This requires the STP to be approved and available at PDR. This in turn compels the Organization's test engineering group, as a separate group, to be involved in evaluating the Software Requirements Document (SRD) immediately after the SRD is drawn up.
- This requires the STP to provide a time phased schedule of asset usage, and can force the Organization to consider if they have enough assets, such as test benches, to support testing at the various levels of assembly, simultaneously evaluating anomalies, making and testing corrections at these levels, and performing dry runs of the completed product. Usage of the test benches will get especially heavy at the end of the project, when the Organization is doing all these activities at once while getting ready to sell off the software.
- The design architecture should be sufficiently detailed that the operation of the software is understandable, reasonable and acceptable.

QC90-S SOFTWARE QUALIFICATION TEST (SQT)

"The Organization shall uniquely identify each Software Requirement in the Software Requirements Document(s), and shall provide a requirements traceability matrix that tracks each requirement through the Software Design Document(s), to the Software Qualification Test Plan and into the SQT Test Procedure, showing that all software requirements are implemented and verified. The requirements traceability matrix shall indicate the test in the SQT Test Procedure verifying each requirement, and the SQT Test Procedure shall indicate the test and step that verifies the requirement.

If any identified requirements cannot be verified using the final software, lower level assemblies shall be tested or code shall be inspected. The Organization's Software Quality Assurance representative shall verify and record the results.

The requirements traceability matrix shall be included as an appendix to the SQT Test Procedure. The SQT Test Procedure and the requirements traceability matrix shall be approved by the Organization's Software Quality Assurance (SQA) representative and the Customer before performance of the SQT.

The SQT Test Procedure shall meet three criteria:

1. It shall verify the software meets each of the requirements imposed.
2. It shall specify the results of each test such that the success or failure of the test can be determined.
3. It shall be written in enough detail that if an anomaly occurs, the test can be exactly repeated to show the anomaly.

The object code used to perform the SQT shall be produced using source code, software, and procedures that are under the Organization's Configuration Management (CM) control. The Organization's Software Quality Assurance (SQA) representative, who shall verify that the process is sufficiently documented that it can be duplicated, shall witness the production and installation of the object code. SQA shall verify the final, CM controlled SQT Test Procedure is used to produce the SQT software and hardware environment. Engineering and Software Quality Assurance representatives from both the Organization and the Customer shall witness the SQT.

Records of all SQT activity shall be documented, treated as quality/acceptance records and made available to the Customer, if requested. All non-conformances shall be entered into the Corrective Action process per QC86 Corrective Action Process. The SQT Test Report shall show evidence of acceptance by the Organization's Software Quality Assurance representative.

It may be necessary to repeat either the SQT, or portions of the SQT, because of non-conformances. The extent of these repeated performances, or delta SQTs, shall be determined by mutual agreement between the Organization and the Customer's Engineering and SQA."

Guidance:

- The SQT shall be performed for all flight and critical Ground Support Equipment (GSE) software.
- The Software Qualification Test (SQT) is the equivalent of the First Article Inspection for hardware. All of the requirements must be verified in the SQT, including extremes and error conditions. The inputs to the software-under-test will come from a software test bench or simulator that provides the necessary range of inputs and error conditions.
- The SQT is performed under rigorous control because there will be no further significant testing of the software.
- Do not confuse the SQT with the Final Acceptance Test (FAT), which is a validation test that assures the Customer that the system is still working by testing a few nominal conditions.

QC91-S CRITICAL DESIGN REVIEW (CDR) DOCUMENTATION

"The Organization shall support the Critical Design Review (CDR) by providing the Customer with approved copies of the Organization's Software Design Document (SDD), and the Software Coding Standards for the language to be used. The Organization's Software Quality Assurance (SQA) function shall approve these documents before being submitted to JPL. JPL shall receive it at least 60 days before the CDR.

The Software Design Document (SDD) shall show the full design of the proposed software and detail the internal interfaces. The SDD shall describe the structure and detailed design of the units, components and assemblies of the contract item.

The Software Coding Standard shall contain the rules, practices and conventions to be used in coding the software. This shall include naming conventions, header format, code format, in-code documentation requirements, and a history of code changes with each change's date and authorization.

Open action items from the PDR shall be resolved, or plans for resolving them will be submitted. A rough draft of the Software Test Procedure shall be submitted showing that all of the requirements are testable. A preliminary copy of the requirements traceability matrix shall be submitted showing all requirements are accounted for in the design and will be tested. A current estimate of Flight Software Margins shall be submitted per QC88-S.

Additionally, the Organization shall submit any previously approved and submitted documents having changes, with the Organization's SQA approval indicated on them. JPL shall receive these re-submitted documents at least 30 days before CDR."

Guidance:

- Requires the SDD to be complete before the coding phase is authorized. This does not preclude any prototype software to determine if a concept works.
- The Software Coding Standard is the software equivalent of a Drafting Standard.
- QC88-S Flight Software Margins should be invoked with this clause. An estimate of margins (reserves) is made, because "software grows".
- The CDR will determine if the detailed software design is understandable, reasonable and acceptable. Attendees from mechanical engineering and electronics will provide their input.

QC92-S TEST READINESS REVIEW (TRR) DOCUMENTATION

"The Organization shall support the Test Readiness Review (TRR) by providing the Customer with approved copies of the Organization's Software Test Description (STD) detailing performance of the Software Qualification Test (SQT), the Release Description Document (RDD) and the **document that used to be called the Firmware Support Manual (FSM)**. The STD shall include the requirements traceability matrix showing that each requirement is verified and where it is verified. The Organization's Software Quality Assurance (SQA) function shall approve these documents before being submitted to JPL. JPL shall receive the STD at least 60 days before the TRR.

Open action items from the CDR shall be resolved, or plans for resolving them will be submitted. The Organization shall show evidence that all of the non-conformance entered in the Corrective Action process have been satisfactorily resolved by authorized changes. The Organization shall show evidence that the SQT has been successfully performed and witnessed by the Organization's SQA group. Properly identified copies of the Source code shall be available from the Configuration Management (CM) group. The current measured value of Flight Software Margins shall be submitted per QC88-S.

Additionally, the Organization shall submit any previously approved and submitted documents having changes, with the Organization's SQA approval indicated on them. JPL shall receive these re-submitted documents at least 30 days before TRR.

Clean copies of the STP shall be provided to all participants in the SQT. A set of "last minute changes" may be presented, provided they are not extensive, as decided by the Customer.

At the end of TRR the Customer's SQA shall witness generation of the object code from the source code obtained from the Organization's CM using the procedure in the Release Description Document (VDD) and loaded into the test hardware using the procedure in **the Firmware Support Manual (FSM).**"

Guidance:

- This is the critical engineering point.

  All of the CDRL documents are complete and approved.

  All of the non-conformances are resolved and corrected by SCCB authorized changes.

  The source code is complete, and controlled by CM.

  All of the processes for changing source code to object code is correctly documented and controlled by CM.

The test environment is documented, tested, and ready to go.

The object code has been completely tested, the test witnessed by the Organization's SQA, and the "dry run" submitted as evidence of the test.

The flight software margins are within the specified range.

"Extensive" changes to (and problems with) the STP are usually obvious. Generally, whole pages are deleted or extensively rewritten. New, unapproved procedures are provided. They indicate the dry run was not properly performed, or last minute changes were made, which were probably not completely tested. It often means that it would be prudent to delay the FQT, if possible.

QC93-S SYSTEM DELIVERY REVIEW (SDR) DOCUMENTATION

"The Organization shall further support the Customer's testing after the Software Qualification Test (SQT) and System Delivery Review of the Organization's product by aiding the Customer's disposition of non-conformances.

For the System Delivery Review the Organization shall provide a status report on the products and processes to be delivered, the supporting documentation, and any problem areas."

Guidance:

- This clause provides support of the software in the transition period after SQT, until JPL employees can become familiar with it and take over its support.

QC94-S SOFTWARE QUALITY ASSURANCE (SQA)

"The Organization shall have Software Quality Assurance (SQA) personnel with access to the highest level of management, the Customer and/or regulatory authorities' representatives. The SQA function shall be organizationally independent of the Program/Project manager and/or have an independent reporting path to senior management above the Program/Project manager.

The SQA function shall review and approve all CDRL documents delivered by the Organization. The SQA function shall witness the Software Qualification Test and monitor selected lower level software tests. The SQA function shall review all software test results for completeness and accuracy of results. The SQA function shall keep a set of records of their activities separate from the CM records. (CM may have a copy of their records.) The SQA function shall act as the interface between Independent Verification and Validation (IV&V) and the Organization.

A SQA engineer shall be a member of the Software Change Control Board and verify non-conformances were completely identified and properly tested after correction. A SQA engineer shall attend all Technical and Project Reviews, and provide input as required.

Guidance:

- For very small Organizations the SQA representative may be the owner, provided that person does not produce software for the SOW.
- The only truly independent IV&V Organization is one that is hired by the Customer. All others tend to gloss over problems, because they want their Customer's future business as an IV&V Organization.

QC95-S INDEPENDENT VERIFICATION AND VALIDATION (IV&V)

"The Organization shall have its Software Quality Assurance (SQA) function interface with an external Independent Verification and Validation (IV&V) Organization retained by the Customer. The IV&V Organization shall have access to the SQA records.

Should the Organization not have an SQA function, the IV&V Organization will act as an SQA function. The IV&V function shall have access to the same records and perform the same duties as the SQA function would have."

Guidance:

- The IV&V Organization must be financially independent of the Organization. If it is not, there is a high probability that it will report only information that the Organization wants reported. The IV&V Organization must sign a non-disclosure agreement with the Customer. All information examined must be considered proprietary.
- The IV&V Organization should interface with the Customer's SQA and the Organization's SQA functions.

QC96-S CAPABILITY MATURITY MODEL INTEGRATION (CMMI)

When Specifying Compliance to **CMMI Level 2**:

"The Organization shall have a completed a program which complies with CMMI Level 2 management practices as described in Carnegie Mellon Software Engineering Institute (SEI) document "Capability Maturity Model Integration (CMMI) Version 1.1."

Third party certification / registration is not required. *

When Specifying Compliance to **CMMI Level 3**:

"The Organization shall have a completed a program which complies with CMMI Level 3 management practices as described in Carnegie Mellon Software Engineering Institute (SEI) document "Capability Maturity Model Integration (CMMI) Version 1.1."

Third party certification / registration is not required. *

When Specifying Compliance to **CMMI Level 4**:

"The Organization shall have a completed a program which complies with CMMI Level 4 management practices as described in Carnegie Mellon Software Engineering Institute (SEI) document "Capability Maturity Model Integration (CMMI) Version 1.1."

Third party certification / registration is not required. *

When Specifying Compliance to **CMMI Level 5**:

"The Organization shall have a completed a program which complies with CMMI Level 5 management practices as described in Carnegie Mellon Software Engineering Institute (SEI) document "Capability Maturity Model Integration (CMMI) Version 1.1."

Third party certification / registration is not required. *

* JPL will, on request of Procurement, provide CMMI registered auditors to verify CMMI compliance.

QC97-S SOFTWARE DEVELOPMENT PROGRAMS (ISO 90003:2004)

A. Organization shall provide and maintain a software development program, which is in conformance with Organization's tailored requirements of ISO/IEC 90003:2004.

B. Organization shall provide and maintain a software development program in accordance with tailored requirements of ISO/IEC 90003:2004 as specified in Customer procurement documents.

QC98-S SOFTWARE CONFIGURATION CONTROL

Organization shall utilize a software version control tool to maintain configuration control of the delivered software including source code.

Organization shall maintain archived backups of the deliverable software including source code.

QC99-S CUSTOMER SOFTWARE AUDITS

Customer shall have the option to perform audits, reviews, and/or verifications at Organization's facilities during the development and test of software to be furnished on this procurement.

QC100-S SOFTWARE DELIVERY DOCUMENTATION

Organization shall deliver documentation of software as specified in the procurement documents. Software documentation shall be sufficient to establish that:

- All requirements are achieved or waivers submitted and approved
- Configuration is correct and deliverables are properly identified and marked
- Planned level of acceptance is achieved and/or deviations/waivers are made part of the deliverable documentation package.
- Operating instructions accompanying the developed software are sufficient to enable loading, initialization, and operation by Customer's personnel.

QC101-S CONTROL OF TEST SOFTWARE

Organization shall provide and maintain a system for the control of software used in the qualification/acceptance testing of deliverable hardware, software, and firmware to be furnished on this procurement. Organization shall maintain procedures and test records on items delivered to Customer including test software, and these records shall be available for Customer review.

QC102-S ORGANIZATION SOFTWARE QUALITY MANAGEMENT SYSTEM

A. Organization shall provide and maintain a Software Quality management system that complies with SAE AS 9100 and SAE AS 9006.

B. Organization shall provide and maintain a Software Quality management system that complies with NASA-STD-8739.8 (Software Assurance Standard) and NASA-STD-8719.13B (Software Safety Standard)